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## CYBER SECURITY

Rising levels of cyber attacks renew military efforts to mandate the latest encryption and modes of safeguarding data on the move and data at rest. PG. 14



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# Welcome to the newly designed *Military & Aerospace Electronics*



BY John Keller  
EDITOR IN CHIEF

Welcome to the redesigned *Military & Aerospace Electronics* magazine — the latest in a series of improvements to the publication of enabling technologies for aerospace and defense applications since the magazine first published in January 1990.

The latest redesign is the first major overhaul to the magazine in at least 10 years, and the first since the publication celebrated three decades in circulation last year.

*Military & Aerospace Electronics* has a fresh new logo that emphasizes electronics as the magazine's chief technology focus. The idea is to make it clear where our attention lies — electronic and electro-optical enabling technologies for military and aerospace systems.

This involves electronics in computers, trusted computing and cyber security, unmanned vehicles, sensors, RF and microwave components, power electronics, communications, and test and measurement.

*Military & Aerospace Electronics* also concerns electronics in a long list of technologies and applications that includes, but is not limited to, adhesives and encapsulants; aviation; C4ISR; data storage; electro-optics; electronic warfare (EW); embedded computing; high-reliability electronics; cabling and connectors; power electronics; RF and microwave; sensors; software; test and measurement; avionics; artificial intelligence (AI); sonar; open-systems standards like SOSA and CMOSS; hypersonics; design and development tools; electromagnetic warfare; and rugged computers for use on the tactical edge.

The magazine's redesigned pages are for ease of reading and quick access to information of highest interest to engineers, engineering managers, program managers, and executive managers of military and aerospace electronic systems.

The clean and simple look of the magazine's cover not only is intended to provide information at a glance, but also reflects the publication's evolution

from a tabloid-size news and features magazine that started with volume 1, number 1 in January 1990, and has transformed to a sleek and streamlined look for the 21st century more than three decades later. For these improvements, we owe a special shout-out to the *Military & Aerospace Electronics* editorial art director, Kermit Mulkins.

Each new page is designed with the reader in mind, with quick access to enabling technologies, industry-driving applications, influential suppliers and systems integrators, and stories, features, and briefs to get designers the information they need about contracts, procurement opportunities, and evolving technologies.

Vibrant color photos, drawings, and tables jump off of virtually every page to show readers what's important and new. In short, the redesigned *Military & Aerospace Electronics* is streamlined to get readers the information they need most.

While much of the magazine's look and feel has been updated, the heart of the content is what readers know and depend on: news and briefs about the latest developments in technology, applications, open-systems standards, and design trends; an in-depth Special Report on how aerospace and defense applications are influencing technology; a Technology Focus feature on the evolution of influential technologies of crucial importance to aerospace and defense systems; focused departments on RF and microwave technology, unmanned vehicles, and electro-optics technology; product applications design-in case studies to highlight trending technologies; and the month's most important new products.

Improvements to *Military & Aerospace Electronics* are all about you, the reader, and what you need — fast. Our hope is to keep you informed, and then let you get back to work. With more than 30 years of publishing under our belts, we expect to be here for another three decades — and more. ◀



# Foundational security: Built to protect.

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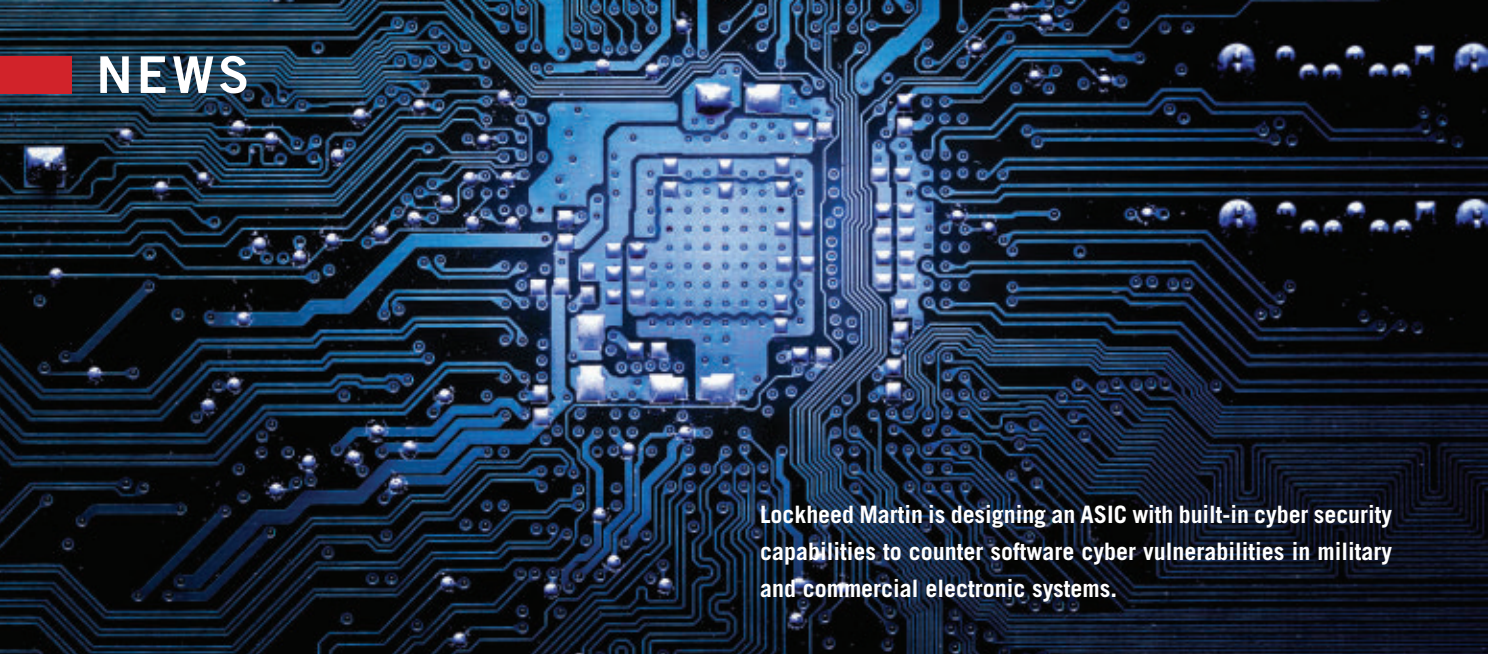
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Lockheed Martin is designing an ASIC with built-in cyber security capabilities to counter software cyber vulnerabilities in military and commercial electronic systems.

# Lockheed Martin to develop ASIC hardware to counter cyber vulnerabilities

BY John Keller

**WRIGHT-PATTERSON AFB, Ohio** — Trusted computing experts at Lockheed Martin Corp. will develop an application-specific integrated circuit (ASIC) with built-in cyber security capabilities to counter software cyber vulnerabilities in military and commercial electronic systems.

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, announced a \$13.6 million contract to the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., for the System Security Integrated Through Hardware and Firmware (SSITH) ASIC effort.

SSITH aims to secure computer hardware that constrains and reduces vulnerabilities to cyber attack and protects against software attacks that exploit hardware vulnerabilities. The Air Force Research Lab awarded the contract on behalf of the U.S. Defense Advanced research Projects Agency (DARPA) in Arlington, Va.

Electronic system security has become a critical area of concern for the U.S. Department of Defense (DOD) and the broader U.S. population, DARPA officials explain. Current cyber security efforts to provide electronic security largely rely on software, which can be inadequate if fails to address the underlying hardware vulnerability.

Creative hackers can develop new ways to exploit how software accesses hardware, which can start a continuous cycle of exploitation, patching, and subsequent exploitation. Instead, the DARPA SSITH program focuses on hardware security at the microarchitecture level.

Lockheed Martin was one of the nine original SSITH contractors named in early 2019. In addition to Lockheed Martin, the original SSITH contractors were Galois Inc. in Portland, Ore.; The Charles Stark Draper Laboratory in Cambridge, Mass.; SRI International in Menlo Park, Calif.; Cornell University in Ithaca, N.Y.; University of California-San Diego in La Jolla, Calif.; Columbia University in New York City; Massachusetts Institute of Technology (MIT) in Cambridge, Mass.; and University of Michigan in Ann Arbor, Mich.

The SSITH project is developing security approaches that will limit computer hardware to states that are secure while maintaining the system performance and power. The project uses architectures and design tools that enable system-on-chip (SoC) designers to safeguard hardware against all seven known common weakness enumeration (CWE) classes of hardware vulnerabilities that hackers can exploit through software.



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SSITH architectures and design tools may provide flexible solutions applicable to DOD and commercial electronic systems. Security measures may include cryptography; metadata tagging; formal verification; verified state matching; anomalous state detection; secure multi-party computing; semi-homomorphic computing; and security through compartmentalization.

Systems designers might eventually be able to use SSITH security architectures so that existing application software can run on secure hardware without software modification; some software modification may be necessary, however, to

exploit hardware security features fully. SSITH architectures are expected to be scalable such that they can be useful for architectures ranging from small, ultra-low power systems to large, high-performance systems. ◀

The SSITH program has two technical areas: scalable, flexible, and adaptable integrated circuit security architectures that can be implemented easily in DOD and commercial SoCs; and ways to evaluate these architectures. For more information contact Lockheed Martin Rotary and Mission Systems online at [www.lockheedmartin.com](http://www.lockheedmartin.com), or DARPA at [www.darpa.mil](http://www.darpa.mil).

## KBR Centauri to develop imaging radar detection algorithms for ground moving targets

BY John Keller

WRIGHT-PATTERSON AFB, Ohio — U.S. military researchers needed algorithms and collection techniques to enable synthetic aperture radar (SAR) sensors to detect, geolocate, and image moving targets on the ground. They found their solution from the KBR Inc. Centauri segment in Chantilly, Va.

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, announced an \$11.1 million contract to KBR Centauri in April for the Moving Target Recognition (MTR) project.

MTR revolves around recognizing slow-moving military vehicle targets with synthetic aperture radar (SAR) signatures that are superimposed on clutter. The Air Force awarded the contract on behalf of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

MTR will include airborne data collection experiments to test and evaluate algorithms to detect moving ground targets. KBR Centauri experts will be responsible for the airborne radar sensors and flight services, while DARPA will handle designing



**Radar operators aboard future surveillance aircraft may have improved ability to track and classify moving targets on the ground from technologies developed in the MTR program.**

experiments that involve moving ground vehicles, instrumented to provide ground truth.

If the project succeeds at moving target detection, geolocation, and imaging, MTR will start developing ATR algorithms for moving target images.

The MTR program is part of the DARPA Mosaic Warfare vision, which seeks to create rapidly reconfigurable military forces that are fast, unpredictable, flexible, and adaptable — more like the pieces in a mosaic piece of art, rather than a collection of rigidly designed pieces of a puzzle.

The MTR program has two phases: a two-year effort that focuses on locating moving targets, as well as detection and imaging; and automatic target recognition (ATR) of the moving target images. Several contract awards are expected. ◀

On this contract KBR Centauri will do the work in Ann Arbor, Mich., and Navarre, Fla., and should be finished by January 2024. For more information contact KBR Centauri online at [www.kbr.com/en/centauri](http://www.kbr.com/en/centauri), the Air Force Research Laboratory at [www.afrl.af.mil](http://www.afrl.af.mil), or DARPA at <https://www.darpa.mil>.





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BY **John Keller**

researchers point out. Adversaries exploit misinformation and true information on blogs, tweets, and other online multimedia content.

Today, the ability to detect and make sense of geopolitical influence campaigns largely is a manual and ad hoc process. Analysts use social listening tools to formulate complex keyword queries; track trending keywords, hashtags, and topics; and read hundreds to thousands of documents to identify influence themes.

Marketing tools for analyzing audience demographics, interests, and personality, for example, lack explanatory and predictive power for deeper issues of geopolitical influence.

INCAS primarily will use publicly available data sources including multilingual, multi-platform social media, online news sources, and online reference data. ←

The U.S. is engaged with its adversaries in an asymmetric and continual war of weaponized influence narratives, DARPA

INCAS has five technical areas: influence indicator detection; population response characterization; influence campaign modeling; data and testbed development; and program evaluation. For more information contact USC online at <https://research.usc.edu>, or DARPA at [www.darpa.mil](http://www.darpa.mil).



Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a \$5.4 million contract to USC in July for the Influence Campaign Awareness and Sensemaking (INCAS) project.

USC joins Protagonist Technology LLC in San Francisco on the INCAS project. Protagonist won a \$5.4 million contract last month for the DARPA INCAS project.

INCAS seeks to uncover computational techniques and tools that help intelligence analysts detect and make sense of geopolitical online influence campaigns on social media and in other multimedia online content. Additional contracts may be awarded.

The U.S. is engaged with its adversaries in an asymmetric and continual war of weaponized influence narratives, DARPA



### Starlink satellites move data quickly with lasers for speed and low latency

One of the next big upgrades in telecommunications will involve satellites firing lasers at each other—to beam data, not blow stuff up. The upside of replacing traditional RF communication with lasers, that encode data as pulses of light is like deploying optical fiber for terrestrial broadband: fast speeds and low latency. The first batch of laser-equipped Starlink satellites went up to polar orbits in January. Its most recent launch last month featured version 1.5 spacecraft with the latest laser technology. SpaceX in Hawthorne, Calif., the builder of Starlink, may be getting the most attention for its use of optical communications, but several companies are developing laser systems to deploy on satellites and even in applications closer to Earth.

### Army considers digital engineering to design new armored combat vehicle

The U.S. Army is using digital engineering and simulations to develop its next-generation ground combat vehicles, including the Optionally Manned Fighting Vehicle (OMFV). In its simplest iteration, digital engineering moves the design process from 2D blueprints to 3D virtual models, which can then be plugged into realistic simulations to test performance. Army officials say they plan to use a digital engineering approach to develop the OMFV, which is being designed to replace the M2 Bradley Fighting Vehicle armored personnel carrier. Army leaders still are working out how they will implement digital engineering.

### AI-driven situational awareness may help military anticipate future events

What if by leveraging today's artificial intelligence (AI) to predict events several days in advance, countries like the United States could simply avoid warfare in the first place? It sounds like the ultimate form of deterrence, a strategy that would save everyone all sorts of trouble and it's the type of visionary thinking that is driving U.S. military commanders and senior defense policymakers toward the rapid adoption of AI-enabled situational awareness. In July 2021, the North American Aerospace Defense Command (NORAD) and U.S. Northern Command (NORTHCOM) conducted a third series of tests called the Global Information Dominance Experiments (GIDE), in collaboration with leaders from 11 combatant commands. ←



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# DARPA eyes feasibility of cryogenic cables and connectors for quantum computing

BY John Keller

**ARLINGTON, Va.** — U.S. military researchers are asking industry to determine the feasibility of developing high-density connectorized cryogenic cables for future use in superconducting classical computing, superconducting quantum computing and quantum annealing, and superconducting single-photon detector arrays.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a solicitation in August for the High Density Connectorized Cryogenic Cables project.

Cryogenic cables are for use in low temperatures, and are made of low-thermal-conductivity metal materials on center and outer conductors, which minimize the effects of low temperatures from outside the cables.

The goal is to create a new type of high-density data cable for superconducting electronics applications with high density, low attenuation, low crosstalk, and low heat load.

One of the more difficult aspects about developing a superconducting electronics technology at low temperatures of about 10 millikelvin is the lack of suitable commercial input/output data cables, DARPA researchers explain.

Existing solutions often either are proprietary or are very-low-density coaxial cables. When they are available commercially, moreover, connectorized cryogenic cables often are only available from non-U.S. vendors.

High-quality cryogenic data cables are an extremely challenging. High quality cables should be simultaneously low loss and low heat load, which are goals that often are directly at odds.



DARPA researchers are looking for high-quality cables with many channels per cable, and with very low crosstalk. These competing requirements likely will demand a creative solution, experts say.

Ultimately, these cables should meet DARPA requirements, and seed a commercial technology that will enable a new generation of cryogenic information processing technologies.

Cables should have 8 to 16 channels per cable, with 128 to 256 channels per 4-inch vacuum feedthrough; -40 to -50 decibels of normalized crosstalk;

◀ **DARPA researchers want to develop cryogenic cables for future superconducting quantum computing, and superconducting single-photon detector arrays.**

1.5 to 5 decibels per meter of insertion loss; and 2 to 5 nanowatts of heat load at 20 millikelvin.

Researchers are interested in how well cables can scale to higher connector densities, longer cable lengths, maximum operating frequencies; insertion loss at temperatures as high as room temperature; heat load at temperatures from 4 to 50 Kelvin; and signal phase matching within cables and cable-to-cable.

In addition, researchers want to know the cable's minimum bend radius, customer-defined impedance values; compatibility with integrated passive components and cryogenic vacuum

connections; mean time between failures at cryogenic temperatures; mean time between failures at mean thermal cycles; and expected commercial prices.

Phase-one contractors will perform a feasibility and design study, and produce a technical design for a high-quality cryogenic cable, and provide experimental or numerical evidence that their proposed solution will meet requirements.

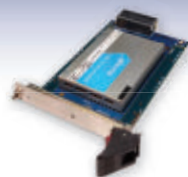
DARPA may select performers from phase one for continuation into phase two to develop, manufacture, and characterize designs, and lay the groundwork for a new commercial cryogenic cabling solution.

In the program's first phase companies will compete for six-month worth as much as \$175,000. Companies selected will be asked to submit phase-two proposals by invitation. The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR). ◀

Companies interested were asked to submit proposals no longer than 20 pages to the U.S. Department of Defense SBIR/STTR Proposal Submission website by 28 Sept. 2021 at <https://www.sbir.gov/content/submission-proposals>. Email questions or concerns to DARPA at [HR001121S0007@darpa.mil](mailto:HR001121S0007@darpa.mil). More information is online at <https://sam.gov/opp/7fe6084a108c40ec872366829ef550cc/view>.

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# Leidos to develop software for a Navy ASW decision-support system

BY John Keller

**SAN DIEGO** — Systems integrators at Leidos Digital Solutions Inc. in Vienna, Va., will provide software development and engineering for a U.S. Navy decision-support system designed to help Navy commanders plan submarine warfare attacks on enemy vessels.

destroyers, aircraft carriers, and shore installations. It enables commanders to share key tactical data among ASW surface ships, aircraft, and shore sites in near real-time, and is the only Navy program of record that provides an undersea warfare common tactical picture, Navy officials say.

The USW-DSS ASW decision-support system complements and provides an interface with common operational picture systems such as the Global Command and Control System-Maritime (GCCS-M), as well as Link 11 and Link 16 tactical data links.

When the AN/UYQ-100 is deployed on destroyers, the Navy's surface ship ASW combat system AN/SQQ-89 provides ship, sensor, and track data to USW-DSS. The CVN Tactical Support System (CV-TSC) provides this data when the system is installed on carriers.

These data sources enable USW-DSS to generate and share a composite track picture that enables ASW ships and aircraft to share weapons control. The system's decision-support tools operate on existing shipboard computers and communications links.

The system's USW-DSS advanced capability build 2 (ACB-2) release 3 (B2R3) completed initial operational test and evaluation (IOT&E) in 2013. By 2019 the USW-DSS had been delivered to 35 surface warships and aircraft carriers, and is operational at three shore commands and five training sites.

The latest system uses the Consolidated Afloat Network and Enterprise Services (CANES) computers and is installed as software. The AN/UYQ-100 has been operational with the fleet since 2010, and through 2019 Navy leaders plan to install the system on 65 ships and shore sites. ◀

Leidos should be finished with this order by December 2023. For more information contact Leidos Digital Solutions online at [www.intranetquorum.com](http://www.intranetquorum.com), or the Naval Information Warfare Center Pacific at [www.niwpacific.navy.mil](http://www.niwpacific.navy.mil).



**Leidos Digital Solutions is developing software for a U.S. Navy decision-support system designed to help Navy commanders plan submarine warfare attacks on enemy vessels.**

Officials of the Naval Information Warfare Center Pacific in San Diego announced a \$4.5 million order to Leidos in March to support the AN/UYQ-100 Undersea Warfare Decision Support System (USW-DSS) command and control program.

The AN/UYQ-100 provides network-centric capability that enables Navy anti-submarine warfare (ASW) commanders to plan and coordinate destroyer and aircraft carrier operations against enemy submarines. The system enables commanders to establish and maintain a common tactical picture and execute tactical control, Navy officials say.

Leidos will provide systems engineering; software development; enterprise engineering; software build management; infrastructure integration; testing; technical writing services; system documentation; and cyber security engineering.

The USW-DSS installs open-architecture decision-making tools as software on computers aboard Navy Arleigh Burke-class



# Raytheon to build ESSM Block 2 shipboard missiles in potential \$1.3 billion deal

BY John Keller

**WASHINGTON** — Missile experts at Raytheon Technologies Corp. will build two years' worth of next-generation shipboard missiles able to defeat a wide variety of aircraft and missile threats with an active radar seeker than can operate independently of the launch ship under terms of a potential \$1.3 billion contract.

Officials of the U.S. Naval Sea Systems Command in Washington are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., for 2021-2023 RIM-162 Evolved Seasparrow Missile (ESSM) Block 2 full-rate production. The contract's initial value is \$358 million. With options the contract could reach nearly \$1.3 billion over the next six years.

The ESSM Block 2 first was deployed with the Navy and allied navies last year. It is a ship self-defense missile with a dual-mode X-band radar seeker than can engage enemy planes and missiles at ranges beyond 25 miles. RIM stands for radar intercept missile.

Compared with its ESSM Block 1 predecessor, the ESSM Block 2 has increased maneuverability and other enhancements that enable the missile to defeat future threats to U.S. and allied navies operating in hostile environments, Raytheon officials say. The ESSM Block 2's active seeker will support terminal engagement without the launch ship's target illumination radars.

In addition to the U.S. Navy, the governments of Australia, Belgium, Canada, Denmark, Germany, Greece, The Netherlands, Norway, Portugal, Spain, and Turkey will operate ESSM Block 2 anti-air missile.

ESSM is a medium-range, semi-active homing missile that makes flight corrections via radar and midcourse data uplinks. The missile provides reliable ship self-defense capability against agile, high-speed, low-altitude anti-ship cruise missiles, low velocity air threats like helicopters, and high-speed, maneuverable surface threats.

The missile is 12 feet long and has 10-inch-diameter control and rocket motor sections that taper to an 8-inch-diameter guidance section with a radome-protected antenna for semi-active homing and a warhead. It has a high-thrust, solid-propellant rocket motor and tail control via a thrust vector controller.

The first production ESSM Block 1 was delivered in late 2002 and has been in full operational use in the U.S. since 2004.



**RIM-162 Evolved Seasparrow Missile (ESSM) Block 2 has a dual-mode X-band radar seeker than can engage enemy planes and missiles at ranges beyond 25 miles.**

Raytheon will do the work on this contract in Tucson, Ariz.; Edinburgh and Eight Mile Plains, Australia; San Jose, Torrance, and Westlake Village, Calif.; Raufoss, Norway; Mississauga and Cambridge, Ontario; Ottobrunn, Germany; Nashua, N.H.; Hengelo Ov, The Netherlands; H Koropi Attica, Greece; Canton, N.Y.; Ankara, Turkey; Grenaa and Lystrup, Denmark; Madrid; Milwaukie, Ore.; Lawrence, Maine; and Clearwater, Fla., and should be finished by March 2025. ◀

For more information contact Raytheon Missiles & Defense online at [www.raytheon-missilesanddefense.com](http://www.raytheon-missilesanddefense.com), or Naval Sea Systems Command at [www.navsea.navy.mil](http://www.navsea.navy.mil).

# CYBER BATTLEGROUND

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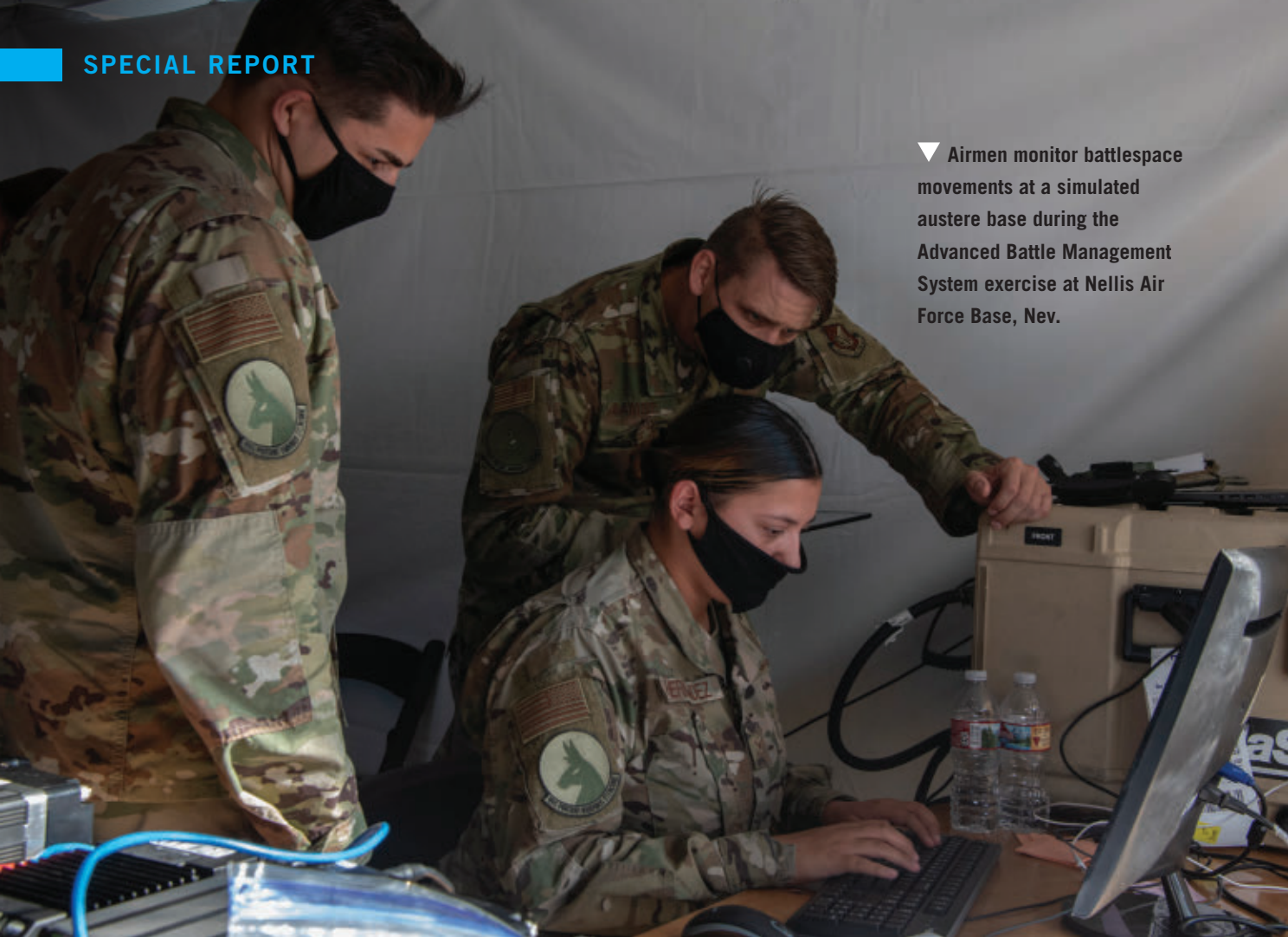
# BEER ROUNDS

Trusted computing, cyber warfare,  
and cyber security **for national defense**

BY Megan Crouse

**E**ncryption and securing data have been a concern for a long time. This year an increasing number of cyber attacks, more refined attackers, and changes in the way the U.S. military connects devices from across services all add wrinkles to the data battleground.

The threat categories are many. Vehicle loss or capture, data loss or transport, nation state hackers or internal threats all can threaten or intercept data at rest, data in motion and physical technology. On top of basic measures to separate data, like virtual private networks, supply chain resilience and new frontiers like artificial intelligence and quantum computing are a big part of the conversation today.



▼ Airmen monitor battlespace movements at a simulated austere base during the Advanced Battle Management System exercise at Nellis Air Force Base, Nev.

### New efforts

You've likely seen the Pentagon's \$10 billion JEDI cloud services contract in the news, due in part to big-name big-budget rival partners Microsoft and Amazon. In July, the Pentagon canceled the cloud contract, saying "due to evolving requirements, increased cloud conversancy, and industry advances, the JEDI Cloud contract no longer meets its needs." However, the U.S. Department of Defense (DOD) still plans to solicit both tech giants for the program's replacement, the Joint Warfighter Cloud Capability (JWCC).

This new project will be the central pillar of Joint All-Domain Command and Control (JADC2), the Pentagon's plan to connect all cloud-enabled intelligence, surveillance, and weapons systems across all services. JADC2 will include some artificial intelligence (AI), to the tune of an expected \$874 million allocation in 2022. The Pentagon expects to make the direct rewards for it around April 2022, and open it up to wider competition around 2025.

Also in the news is a plug-in security solution for the U.S. Army, the Air and Missile Defense Workstation (AMDWS), produced by Northrop Grumman Corp. and announced as a \$21.7 million contract in September. This software suite is designed to improve decision-making for Army commanders.

### What do adversaries want?

Protecting digital assets goes hand-in-hand with protecting physical ones.

"In the context of military systems, the U.S. wants to preserve its tech advantage," says Steve Edwards, director of secure embedded systems at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va. "In a lot of cases the attacker is after the algorithms or software that's running on a system that would provide that kind of advantage ... whether it's some unique radar-tracking algorithm or image-processing algorithm. In some cases it's the data the system collects."

The number of attacks, furthermore, is rising. Last march the FBI's 2020 internet crime report showed the number of internet crime complaints reported rose 69.4 percent year over year.

It's generally recommended to use multiple security layers for encryption and authentication. Those could include usernames, passwords, two-factor authorization, or as many as three- and four-factor authentication. As in the commercial world, this tactic is gathering under the name zero trust.

The products with the most defense interest in this area are those with cyber security by the U.S. National Security Agency



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(NSA) in the agency's Commercial Solutions for Classified (CSfC) encryption.

"There is a huge volume of attacks now," says Dominic Perez, chief technology of the Curtiss-Wright PacStar business unit in Portland, Ore. "Attacks add a lot of noise to actual threats. Someone might be knocking on the door, which might obscure the really sophisticated actors. You have the risk of your encrypted tech being captured and used decades from now. That's where the CSfC dual layer concept comes in."



▲ Joint terminal attack controllers from the 274th Air Support Operations Squadron, control aircraft during Exercise Bold Quest 20.2 at Camp Atterbury, Ind.

## NSA regulations

The NSA's CSfC program replaces the previous requirement for organizations with classified data requirements either to build or purchase an NSA Type-1 certified solution. It aims in part to reduce bottlenecks during development created by the time-consuming and expensive Type-1 process. It's a way for the latest commercial technologies to be on a short list of approved products, replacing Type-1's practice of submitting each solution individually.

Curtiss-Wright experts have first-hand perspective on the changes in commercial-military partnerships because a 1990s-era directive for the industry to use commercial-off-the-shelf (COTS) project was the impetus for the Defense Solutions division to exist.

"The CSfC program itself came about and has been in an upward direction in terms of number of entrants both from a vendor and customer perspective. CSfC is a whole ecosystem [which has come along with the] increase in number of vendors, increase in number of people approved," says Steven Petric, senior product manager for data storage at Curtiss-Wright.

That in turn shows "validation to the need that's out there and the growth that's required. Threats are prevalent and new programs are being required to have a NSA-approved encryption solution," Petric says.

Other U.S. approval processes in this area include the National Information Assurance Partnership (NIAP) and the Protection Profiles required as part of the Common Criteria for Information Technology Security Evaluation.

## The problem of time

Another factor is time; if an adversary captures a piece of defense hardware, it has all the time in the world to try to crack it.

"Time is definitely a factor," Edwards says. "It's a question of how long it takes [the adversary] and how much effort they have to put into it. So we're upgrading military systems every three or five years [when there is] a new capability or feature or hardware. If we can prevent the attacker long enough to the point where we don't care anymore, that's a win for us. Or we make it so expensive that they lose interest because they don't have the financial resources or the manpower to go attack it."

Robin Wessel, CEO of CRU Data Security Group (CDSG) in Vancouver, Wash., notes that there is something of an arms race happening related to keeping the data on drones secure.

"There is a lot of focus on ensuring, for example, if a drone were to get knocked out by a countermeasure behind enemy lines that that data is secure and protected." Although that data is likely encrypted behind multiple barriers, the enemy has all the time in the world to crack it.

"It's potentially a ticking time bomb for customers or users. With our technologies incorporating multiple layers of tech, to ensure that they might infiltrate one of the safe guards but to get both becomes exponentially more difficult. I like to think of it as a moat behind a castle. We draw the drawbridge up," CDSG's Wessel says.

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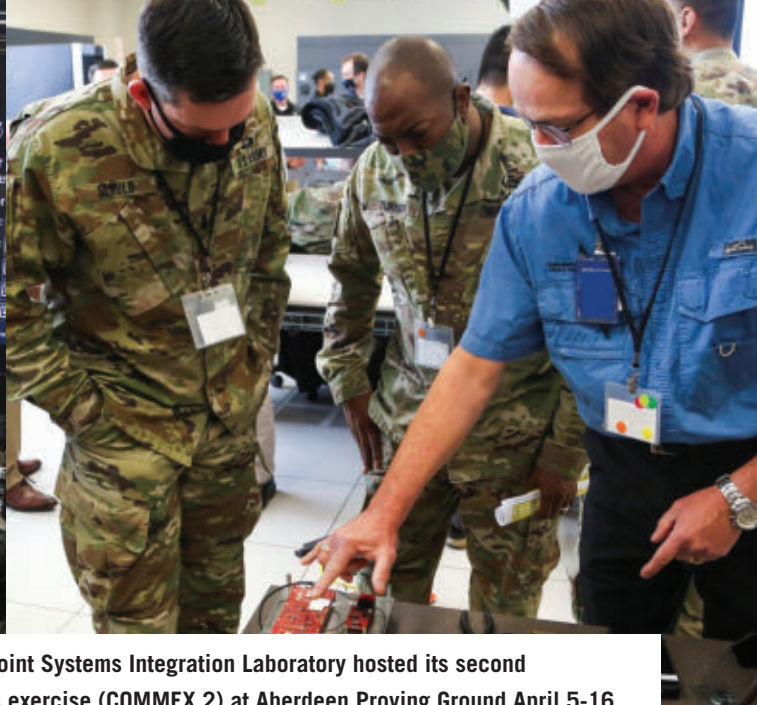
## Each MC-VCM is factory configured for one of the following:

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▲ The Army's Joint Systems Integration Laboratory hosted its second communications exercise (COMDEX 2) at Aberdeen Proving Ground April 5-16.

### Commercial or specialized?

As in other areas of defense electronics this year, the industry has seen some gradual changes in the relationship between commercial and defense products and business partners. However, with only certain providers meeting the NSA's CSfC standards, the options are limited.

"Traditionally, users had two options: on one extreme highly commercial COTS in the truest sense," CDSG's Wessel says. "Parts that have very, very short shelf lives so to support very, very long programs was difficult. They didn't meet a number of the critical certification requirements that cyber security officers and defense agencies require. Or they were not available in the form factors necessary for implementation. On the commercial end it was priced very nicely, but very incompatible through implementation and lacks certification."

The other option, he says, comes from traditional defense-centric organizations

that manufacture drives, which are more specialized but often much more expensive.

"As a result usually their form factors and the technologies they implement are one to two generations behind because this market is very fast-paced," Wessel says.

Therefore, he notes, those more expensive products may not be as good a fit for a world in which the COVID-19 pandemic has pushed more organizations to go digital. That, in terms, increases the number of nodes and clients attackers could target.

Other standard commercial technologies in common use in defense applications include secure boot, which validates and authenticates an operating system and all the points it has to trust. Aaron Frank, senior product manager in the C5ISR business unit of Curtiss-Wright, named Intel Boot Guard and Intel Trusted

Execution Technology (TXT) as commercial products that apply in this space, as do security Field Programmable Gate Arrays (FPGA) devices.

▼ Curtiss-Wright's DTS1 commercial off-the-shelf data-at-rest (DAR) network attached storage (NAS) solution supports two layers of full disk encryption (FDE) in a single device.





## Data at rest

Along with having the right accreditation and making sure vehicles don't fall into adversaries' hands, another element of protecting data at rest is watching for where physical hardware might be simply carried away.

The threat landscape has expanded to every laptop or mobile phone carried by a warfighter or representative. During the Jan. 6 insurrection at the U.S. capitol, a laptop belonging to the House Speaker Nancy Pelosi was stolen. The laptop was used only to make presentations, making it a good example of how physical assets can put data at risk at rest and how sequestering critical data provides an initial barrier to entry.

"One of the most common ways defense departments and government protected data was through physical means," Wessel says. "Taking the drive and removing it from the computer works great because when you air gap something, move it to a physical area, it's pretty hard to hack that data offline. But [outside the office, this] is impractical. Imagine work from home. What are they going to do, stick the drive under their mattress? They may have mobile devices or thin and light laptops that it may be difficult to remove those drives.

"Sensors, drones, vehicles, portable C&C systems — all have copious amounts of data because they're connected to sensors or networked across domains where they're trying to share data with other systems. So, they're storing lots of data locally."

To prevent an attacker from physically removing chips, Wessel's company CDSG includes special coding on drives that mark evidence of tamper. This extends to "even making boards non-probeable," Frank says. "You can't actually get access to signals on the board."

However, important precautions like these can also create tension between keeping data safe and allowing for access by the people who are supposed to be looking at it.

"For example, a data officer is looking at Facebook or Instagram for threats," Wessel says. "You want to keep that network separate from, let's say, a classified network. But they want to see both kinds of that information in one place. In the past to do that you'd literally have a computer for unclassified, another computer with classified intelligence; literally separate computers. You can imagine how complex that set up is, a wall of monitors, tangled cables, a pile of boxes. So there's been a real focus on what's called cross-domain or multi-domain solutions.

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What it's doing is using virtualization to display multiple types of operations on one computer instead of five computers."

And that requires a lot of protection, which goes back to the necessity of encryption, multiple layers of security, and Common Criteria.

### Data in motion

When it comes to data in motion or transit, including on the private and secured cloud used for military applications, many tried-and-true protection measures haven't changed. Encryption algorithms and public keys remain important. However, what has changed in the last year is that there is a renewed focus on security and on not only how powerful we can make tools, but on how to use them correctly.

As Curtiss-Wright's Perez says, "There's no point in having the beefiest lock on your bicycle if it's too much of a hassle and you never lock it up when you go into the store."

In addition, decision makers are more familiar with CSfC now, although it still is a specialized area within the industry. "Not a lot of commercial vendors are really aware of it or outside of a small group within these vendors ... their field application engineers



▲ Capt. Kelly Spencer, a brigade nurse and the officer-in-charge of a minimal care ward at the Seattle Event Center, Wash., checks her email at the nurse's station, April 6, 2020.

may not be as conversant," Perez says. "So, when you try to integrate technology from multiple vendors, such as from CSfC, you have to find a subject matter expert who understands the technology and the complexities of pulling all these things together."

Another aspect of this is ensuring your data in motion protections are practical for warfighters in the field. There has been a lot of development on even the basic work of clarifying terminology in this area lately, Curtiss-Wright's Perez says. The people actively using the technology need to be able to understand and use it without knowing every piece of the underlying infrastructure.

"VPNs are still the primary technology for protecting information in transit," Perez says. "Everyone these days probably uses a VPN to connect to the office. But those are a client-to-server technology, and there's a whole industry around these. Device to device VPN when you're protecting industry is harder. You need to identify the algorithms that are going to be used and how that stuff's going to be authenticated."

One way in which Curtiss-Wright experts see the convenience of today's security tools is in automatically highlighting government-required renewals. PacStar's IQ-Core Software, a management software application which Curtiss-Wright demonstrated in October can manage its Data Transport System (DTS1) rugged secure NAS device, includes automatic warning for expiration periods among its user-facing capabilities.

Quantum computing soon may be part of this conversation as well. As of now, quantum computers are too rare and too specific to their own industry to have to worry about attacks that effect large-scale situations. However, professionals are starting to have conversations about what quantum attacks and defenses look like. Perez says tremendous amounts of power and effort are being put into exploring this. However, that leads to some impracticalities. As he says, no one right now is looking to put a \$1,000 lock on a \$100 bicycle.

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## Zero trust

A lot of cyber security companies in the commercial space are currently pushing the concept of zero trust, a strategy in which data is assumed untrustworthy until proven otherwise.

"They call it zero trust but it all boils down to trusting something," Perez says. That might involve something such as trusting a platform module device on hardware.

He also predicts that Microsoft's focus on secure booting is going to switch from consumer to industry to military. Microsoft also recently made another big shift in terms of cyber security for its consumer products, pushing more options to log in without a password.

"What we're finding is that commercial zero trust applications and solutions work really, really well in the commercial environment but may not always work very well in military downrange austere environments, denied environments," Wessel says. It's often about authentication, and common to authentication as a schema in commercial zero trust is pre-boot authentication for devices. That doesn't work if you need to authorize a laptop downrange.

CDSG addresses this with their DIGISTOR Citadel solid-state drive family of data storage products, which have a pre-boot authentication layer to access the drive. Unlike commercial solutions that would require a network to authorize, this one is local and can be administrated in other ways.

Wessel notes that some of the customers he speaks to believe zero trust and other elements of the latest requirements are too expensive. Instead, they rely on DOD waivers.

"The other thing is, I hate to say it, but zero trust in the military environment ... is slow moving," Wessel says. "They still depend highly on their traditional schemas of security. Very often what I have experienced from talking to program managers or program executive offices is it's kind of a 'don't ask don't tell' a bit in terms of they're often not up on the latest requirements."

### 'Shifting left' and what's next

One message the experts we spoke to wanted to give to customers in particular is that security should be included toward the beginning of the design process for

new infrastructure. Include a subject matter expert at the beginning in what is known as 'shifting left,' or a bringing a task usually performed toward the end of a process closer to the beginning.

"Security needs to be architected in up front," says Edwards. "Whether that's hardware based, [or] cyber security, however you want to define it. It's going to be much more seamless and lower cost if it's thought through up front."

Listening to security experts at the beginning instead of the end of the process can also save money, he says.

Another important element to remember is that a layered approach is always better. Think about security at every stage, including boot security, application security and everything in between.

Customers don't understand how to implement security all the time, says Frank. "Everybody need some level of security in programs today. It really requires the systems designers and the integrators to understand where they need the security. Where are their vulnerability points? And do a security assessment. Maybe it's data at rest, maybe data in motion, maybe for the ability for some malicious content to be added coming off the web, something like that. The most imprint part is for our customers to understand where they are vulnerable." ◀

## WHO'S WHO IN CYBER SECURITY

### Amazon Web Services

Seattle  
<https://aws.amazon.com>

### CRU Data Security Group

Vancouver, Wash.  
<https://cdsg.com>

### Curtiss-Wright Corp. Defense Solutions

Ashburn, Va.  
<https://www.curtisswright.com/>

### Intel Corp.

Santa Clara, Calif.  
<https://www.intel.com/>

### Microsoft Corp.

Redmond, Wash.  
<https://www.microsoft.com/en-us/>

### Northrop Grumman Corp.

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# Data storage: it's all coming up NVMe

Non-Volatile Memory Express is fast, small, and lightweight, yet it still has something to prove when it comes to ruggedization, thermal performance, and power consumption.

BY John Keller

**R**ugged data storage for military and aerospace applications have evolved quickly from rotating to solid-state media, such that for all practical purposes, solid-state data storage is the defacto choice today for defense systems integrators.

It's come to the stage that rotating storage media rarely even are mentioned as alternatives to secure data storage in the military. "Just about everything we are doing now is based on solid-state disk," says Amos Deacon III, president of data storage expert Phoenix International Systems in Orange, Calif. The rare occasions where rotating media are considered options, systems designers must take the time and make the investment to designed specialized ruggedized packages, Deacon says.

So that leaves designers with options in solid-state storage media, and today that overwhelmingly means Non-Volatile Memory Express, better-known as NVMe. "The biggest technical trend in recent years is the transition to NVMe for storage in many, if not all cases," says Dominic Perez, chief technology officer at the Curtiss-Wright Corp. Defense Solutions segment in Portland, Ore.

The biggest advantage of NVMe is pure speed, which for the vast majority of systems designers outweighs NVMe's drawbacks in power consumption, thermal management, and ruggedization. NVMe's speed is the biggest reason that it has surpassed in popularity other solid-state storage media such as Serial AT Attachment (SATA) and Serial Attached SCSI (SAS). SATA is a computer bus interface that

connects host bus adapters to data storage devices like hard disk drives, optical drives, and solid-state drives.

"NVMe is six times faster than SATA and SAS," says Curtiss-Wright's Perez. "Solid-state drives were a revolution a decade ago when they were 10 times faster than a spinning disk, and now we are looking at nearly another order of magnitude speed improvement with NVMe." Perez is involved with the Curtiss-Wright PacStar brand; Curtiss-Wright acquired Pacific Star Communications Inc. (PacStar) in Portland, Ore., last year.

The NVMe design approach enables data storage media such as solid-state drives to access processors via the PCI Express databus, rather than through relatively slow specialized data storage inter-

faces. It also enables host hardware and software to capitalize on levels of parallelism possible in modern solid-state drives. NVMe essentially connects data storage directly to system processors, and avoids throughput bottlenecks of data storage interfaces.

## Increased read/write speeds

NVMe can increase data read and write speeds over SATA by four to five times — sometimes even more. As an example, SATA reaches its upper-speed limits at about 600 megabytes per second, while NVMe can sustain read and write performance of more than 3 to 3.5 gigabytes per second. One principle behind NVMe is switching from serial to parallel data interfaces to increase data throughput.



▲ **The Curtiss-Wright PacStar 451 rugged, small form factor network server is for data storage enables users to set-up and manage their tactical server hardware remotely, and adds support for high-speed NVMe storage.**

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“The amount of data that these NVMe systems can suck in is incredible,” says Robin Wessel, executive vice president of solid-state storage provider DIGISTOR in Vancouver, Wash. “Driving NVMe is increased bandwidth. The speeds are significantly higher than the SATA-based solutions they replace.”

NVMe technology, furthermore, “can record several streams of video or other sensor data simultaneously without a hiccup,” Wessel says. “Industry is moving to NVMe as the standard, and away from architectures of the past like SATA.”

Aerospace and defense applications increasingly rely on speed and the ability to record multiple data streams simultaneously. “For I/O-intensive applications like artificial intelligence (AI) bringing in data from a lot of sensors, these NVMe devices will greatly speed-up workflows. The adoption curve is just starting for the military,” says Chris Kruell, director of marketing at DIGISTOR.



**DIGISTOR NVMe solid-state drives for secure data-at-rest applications deliver fast performance for demanding applications such as artificial intelligence, video editing, visualization, and scientific and engineering modeling and analysis.**

The PCI Express interface for NVMe is gaining widespread popularity in aerospace and defense applications. “We have shifted over to NVMe for our small-form-factor data recorders,” says Rodger Hosking, director of sales in the Mercury Systems Mixed Signal business (formerly Pentek) in Upper Saddle River, N.J. “It offers a more efficient interface because it is PCI Express. Also, it can accommodate SATA solid-state drives.”

NVMe data storage bypasses the SATA interface and goes directly to PCI Express to boost throughput speeds, Hosking explains. “We also can take advantage of the commercial trends to get numbers up and costs down.” Mercury Mixed Signal is shipping NVMe in a rugged rackmount server — even for some ruggedized airborne applications, Hosking says.

“We are using NVMe now in our 100-gigabit Ethernet data recorder, which records optical streams at rates of 12.8 gigabytes per second,” Hosking says. We are using multiple NVMe drives connected with an NVME RAID controlled plugged into a PCI Express controller board. We aggregate those four drives to get the speed that we need, and that is working quite well. We are chasing those two standards, PCI Express and NVMe, and as they evolve they will get faster, more rugged, and more reliable.”

In addition to its big advantages in speed, NVMe also is smaller than SATA and SAS, which lends itself to today’s demands for small size and light weight in aerospace and defense systems. NVMe solid-state drives are much smaller than SATA drives and weigh about four times less, which makes them suitable not only for laptop computers, but also for size- and weight-sensitive military applications. In addition, systems designers can attach NVMe memory components directly to motherboards and single-board computers, which also can cut down on size and weight.

## Drawbacks of NVMe

Not everything about NVMe is an advantage for military and aerospace systems designers. Compared with its predecessors, SATA and SAS, NVMe is more expensive, more difficult to ruggedize, consumes more power, and can be a challenge to keep cool enough for maximum performance.

NVMe memory is not as inherently as rugged as SATA and SAS data storage, which can increase the challenge of packaging NVMe for mobile military applications that must operate in extreme temperatures, shock, and vibration.

“Compared to SATA and SAS, NVMe is immature when it comes to ruggedization,” says Eric Rucker, director of airborne systems at Mercury Systems in Torrance, Calif. (formerly Physical Optics Corp.). “We in Torrance are qualifying M2 and the U.2 format for NVMe, with much larger capacity and much larger drives.” While these kinds of data storage might be appropriate for forward-deployed military command posts, “a jet pulling nine Gs, we haven’t gotten there yet.” Mercury acquired Physical Optics last year.

Mercury has qualified a four-terabyte M2 NVMe drive, and is starting to do flight tests on some of the company’s military platforms that are in development, and may enter production on these systems by fall 2022.

As for NVMe M2 and U.2 drives, “those are not for rugged military applications yet,” says Mercury’s Hosking. We have to do the qualification ourselves. NVMe is quite mature for general-purpose commercial applications, but that extreme environmental performance is a thing we are struggling with.”

Finding the best way to ruggedize NVMe memory for military uses is a common challenge today. “A lot of NVMe comes off the same fabs,” says Curtiss-Wright’s Perez. “Our job is to find the best of the best and make sure it is rugged and reliable enough, and that it fits in the smallest possible space.”

Echoes Mercury’s Hosking: “We are doing a very specialized application that is very demanding, using the best commercial NVMe devices available to us. You take the best and fastest you can get, qualify it, and then try something a little different.”





▼ The Mercury Systems model 2589 3.6-gigasample-per-second ultra-wideband RF/IF Extreme half-ATR data recorder (left) and the MLS NAS-Multi Level Security Network Attached Storage (right) are for rugged airborne data recording uses.

## Thermal management

Perhaps one of the most serious weaknesses of NVMe for rugged military applications is its ability to operate in cold and hot temperatures. The Curtiss-Wright TTC business unit in Newtown, Pa., specializes in onboard aircraft test and measurement, in which data storage media must be subjected to high levels of shock, vibration, and temperature extremes.

“We are looking at technology improvements even in NVMe,” says Sridhar Kanamaluru, chief architect for Curtiss-Wright TTC. “We know our test conditions are very harsh; solutions have to work from -40 to 85 degrees Celsius, and NVMe memories are pretty touchy. At times they do not work at these temperature levels, which imposes additional design constraints for us.”

Compounding the picture is the relatively high power consumption of NVMe vs SATA and SAS storage media. More power consumption means generating more waste heat, which forces designers either to design-in cooling, or throttle-down the speed of the data storage to keep within temperature constraints.

“Thermal management is a challenge; they use more power, so they impose a more stringent engineering design to support data capacities,” Kanamaluru says.

When it comes to cooling NVMe, he says there are several ways to do it. “There

are mechanical and thermal-management techniques that we could use, such as heat pipes that would enable us to manage the localized heating, and enable us to bring the heat out of the memories and out of the chassis. Also can use thermal electric coolers.” In extreme cases, Kanamaluru says he and his designers can use some of the same kinds of thermal-management techniques that embedded computing manufacturers use to cool hot microprocessors — including liquid cooling.

Kanamaluru acknowledges that often it’s up to NVMe storage designers to design the right kinds of cooling for their systems. “If we had a choice of other technologies, with the right speeds, that operated at a higher temperature, then we would consider that and could use it,” he says. “Vendors we talk to are coming up with their own environmental solutions, and packaging them to enable cooling. We are testing all the NVMe memories that we are buying to shock and vibration profiles to see that they meet requirements.”



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Annapolis, Md.  
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[www.kaman.com/fuzing-precision-products](http://www.kaman.com/fuzing-precision-products)

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**Virtium LLC**  
Rancho Santa Margarita, Calif.  
[www.virtium.com](http://www.virtium.com)

**ZMicro**  
San Diego  
<https://zmicro.com>

For many, however, the thermal-management tradeoffs of NVMe are worth making. "There are more concerns of NVMe around the thermals and cooling for these drives," points out DIGISTOR's Kruell. "People need to take this into account. We offer heat sinks for air transfer and heat exchange."

### Are SATA and SAS dead?

All the obvious design advantages of NVMe over its predecessors may have designers asking, are SATA and SAS data storage dead? The answer, definitely not.

"SATA, the previous generation of data storage technology, is still in wide use," says DIGISTOR's Wessel. "In SATA you don't have to concern yourself as much with connections and signal integrity, yet with PCI Express and NVMe the margins are much less because signal integrity has to be maintained for those kinds of speeds. We will continue to offer SATA-based technologies for quite some time. A lot of the chips are still the same, but the controllers are different. If you want to get a SATA drive five years from now, you certainly can."

The thermal performance of NVMe, at least for now, also may give systems designers

a reason to take a second look at SATA and SAS. Experts point out that NVMe when it throttles-back its performance in particularly hot temperatures places its speeds near that of SATA and SAS. Given the lower costs of SATA and SAS, that might give designers something to think about.

"In a perfect enterprise world, one NVMe drive would give you 3,000 to 4,000 megabytes per second for a single drive, with Gen 4 PCI Express speeds," says Phoenix's Deacon. "But with higher temperatures, the drives basically go to Gen 3 speed, or 400 to 500 megabytes per second, instead of thousands of megabytes. At

those speeds, SATA or SAS drives are much more competitive. SATA is 600 megabytes per second, with 500 megabytes sustained speed.

Now all of a sudden, your SATA speeds are equal to NVMe speeds."

SATA and SAS still have their adherents in the data storage industry. "We are still basically SAS- and SATA-centric as far as storage devices go that we integrate," says Phoenix's Deacon. "We are getting more and more into what they call edge storage applications. Our product line conforms with that nicely, in that we have traditionally made products that are modular, rugged, and have proven to be reliable in harsh environments." ◀



▲ The ADSR-4003-1 data recorder from The Curtiss-Wright TTC business unit is an instrumentation recorder with a built-in file server capability, two 1000 BASE-T Ethernet ports, and as many as three removable solid-state memory cartridges.





# Georgia Tech to build mobile radar to help pilots avoid surface-to-air missiles

BY John Keller

**HILL AIR FORCE BASE, Utah** — Radar experts at Georgia Tech Applied Research Corp. in Atlanta will build a mobile advanced radar system to help combat aircraft pilots learn to operate safely in hostile areas guarded by modern radar-guided surface-to-air missiles.

Officials of the Air Force Life Cycle Management Center at Hill Air Force Base, Utah, announced a \$770 million contract to Georgia Tech to build the Advanced Radar Threat System - Variant 1 (ARTS-V1) systems.

▲ **ARTS-V1 is for military training ranges to help jet fighter-bomber pilots fight effectively against advanced surface-to-air missiles.**

The ARTS-V1 system is for U.S. military training ranges for air crew training and tactics development to help jet fighter-bomber pilots fight effectively against advanced surface-to-air missiles.

The ARTS-V1 system is for several different aircraft -- especially for 5th generation aircraft like the F-35 joint strike fighter for enhanced training realism. The contract also will

enable Georgia Tech engineers to buy long lead items, support equipment, and spare parts, and software.

The Air Force is awarding the contract to Georgia Tech sole-source because an open competition would cost too much, duplicate expenses, and delay production schedules, Air Force officials say.

ARTS-V1, which has five operators, tracks and engages several targets simultaneously, and reacts to aircrew and aircraft defensive measures. The weapon systems are integrated on a transportable and ruggedized system able to go over all range terrain to include driving on gravel, dirt, and paved roads.

The system simulates threats at full radiated power, and replicates threat signals, antenna patterns, operational modes, and threat capabilities. It sends real-time radar data to the range control center or live missions operations center together with the range's digital integrated air defense system-controlled threat environment for processing and analysis.

The ARTS-V1 system includes antenna; transmitters; command, control, and communications (C3) equipment; power-generation equipment; and other ground support equipment.

Also in late October, the Air Force awarded an \$80.7 million order to the Lockheed Martin Missiles and Fire Control segment in Grand Prairie, Texas, to build five Advanced Radar Threat System - Variant 2 (ARTS-V2) systems, and for ARTS-V2 production option two.

The ARTS-V2 is a ruggedized mobile system designed to emulate radar-guided surface-to-air missile threats. Lockheed Martin will build the ARTS-V2 to provide threat-representative radar tracking and reaction such as acquiring, tracking, and engaging several aircraft simultaneously with representative receiver, processor, and electronic counter-countermeasures.

The system will emulate advanced anti-aircraft missile radiated power, threat signals, antenna patterns, operational modes, and threat tactics. ARTS-V2 will provide multi-spectral threat representation.

The ARTS-V2 is part of the overall Advanced Radar Threat System (ARTS) project to develop and field high-fidelity threat phased array radar for live, virtual, constructive aircrew training for anti-access and area-denial environments. ←

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On the ARTS-V1 contract Georgia Tech will do the work in Atlanta, and should be finished by October 2027. For more information contact Georgia Tech Applied Research Corp. online at <https://gtarc.gatech.edu/gtarc>, Lockheed Martin Missiles and Fire Control at [www.lockheedmartin.com](http://www.lockheedmartin.com), or the Air Force Life Cycle Management Center-Hill Air Force Base at [www.hill.af.mil](http://www.hill.af.mil).

### **Specially configuring 5G cell towers could create surveillance imaging sensor**

The U.S. Air Force and the U.S. Department of Defense are funding research into the possible use of 5G wireless communications as a radar-like surveillance imaging sensor. 5G is the latest iteration of the cellular network. The technology, which makes use of much higher frequencies, can transmit data significantly faster than the previous version, as high as 4 gigabits per second. The high frequency of the very high-speed millimeter wave 5G means that it doesn't take much for the signal to be blocked, and cell towers need to be installed at a higher density. Radar works by transmitting radio waves and then measuring how they bounce back. How long it takes for the radio waves to return is relative to the distance of the object from which the waves bounce. Using direction waves in a narrow beam, and spinning the antenna, helps determine the direction of objects 360 degrees around the object. Radar has the advantage of not being limited by ambient light and working over long distances.

### **Directional coupler for electronic warfare (EW) introduced by KRYTAR**

KRYTAR Inc. in Sunnyvale, Calif., is introducing the model 110050030 dual-directional RF and microwave coupler for electronic warfare (EW), 5G communications, satellite communications (SATCOM), radar, and antenna beam forming. The model 110050030 offers 30 dB of coupling over the broadband frequency range of 10 to 50 GHz (X through Q-Bands), in a compact and lightweight package. The RF and microwave coupler is for systems applications that require external leveling, precise monitoring, signal mixing, or swept transmission and reflection measurements. The directional coupler also lends itself to wireless designs and many test and measurement applications from X through Q-band including commercial wireless, signal monitoring and measurement, and EMC testing. The model 110050030 offers nominal coupling of 30 decibels, plus-or-minus 2.0 decibels, and frequency sensitivity of plus-or-minus 2.0 decibels. The directional coupler exhibits insertion loss of less than 1.5 decibels, directivity of greater than 10 decibels, maximum voltage standing wave ratio (VSWR) is 1.9, input power rating is 20 Watts average, and 3 kilowatts peak. For more information contact KRYTAR online at <https://krytar.com>. ←





The Maritime Strike Tomahawk has improved navigation and in-flight targeting to attack enemy ships at sea. The missile fires from Navy surface warships and submerged submarines.

# Raytheon to produce sensor seeker technology for Tomahawk Block-5 missile

BY John Keller

**PATUXENT RIVER NAS, Md.** — U.S. Navy guided missile experts are asking Raytheon Technologies Corp. to provide seeker upgrades for the BGM-109 Tomahawk missile Block 5A to enable the weapon to hit moving ships at sea.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a \$19.6 million order Friday to the Raytheon Missiles & Defense segment in Tucson, Ariz., to produce new sensors and subsystems that provide midcourse and terminal guidance for the Maritime Strike Tomahawk (MST).

The Maritime Strike Tomahawk, also called Tomahawk Block 5A, was introduced in 2021 with improvements to navigation and in-flight targeting that enable the long-range subsonic missile to attack enemy ships at sea. The missile fires from Navy surface warships and submerged submarines.

The maritime-strike Tomahawk Block-5A has updated seeker technology and processing capabilities to enable the missile to hit moving targets at sea.

Navy joint task force commanders increasingly face long-range anti-ship missiles that threaten their surface forces and potentially deny access to mission-critical areas of operation, so they need a near-term capability to counter hostile surface forces. Without this, the Navy could face loss of life or critical mission failure, Navy officials say.

Raytheon can integrate a new sensor suite into the Tomahawk missile that consists of a new seeker, processor, software, and a new inertial measuring unit for terminal maneuvers, as well as redesigned power budget and system cooling. ←

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On this order Raytheon will do the work in Tucson, Ariz.; Boulder, Colo.; Dallas; North Logan, Utah; Pontiac, Mich.; and other continental U.S. locations, and should be finished by October 2024. For more information contact Raytheon Missile Systems online at [www.rtx.com/our-company/our-businesses/rmd](http://www.rtx.com/our-company/our-businesses/rmd), or Naval Air Systems Command at [www.navair.navy.mil](http://www.navair.navy.mil).

# Lockheed Martin to build EW for helicopters to defend against anti-ship missiles

BY John Keller

**LIVERPOOL, N.Y.** — U.S. Navy surface warfare and missile defense experts are asking Lockheed Martin Corp. to build additional helicopter-based long-range electronic warfare (EW) systems to protect Navy surface ships from existing and future advanced anti-ship missiles.

or together with the ship's onboard AN/SLQ-32(V)6 Surface Electronic Warfare Improvement Program (SEWIP) Block 2 to detect an incoming missile and then evaluate where it is going, Lockheed Martin officials say. AOEW then uses radio frequency countermeasure techniques to deter the missile.

The AOEW program is intended to devise countermeasures for some of the world's most advanced radar-guided anti-ship missiles, such as the Russian-made SS-N-22 Sunburn and SS-NX-26 Oniks.

Lockheed Martin won the industry competition to develop and build the AOEW system in early 2017. The program attracted attention from some of the nation's top-tier EW houses such as Raytheon Co. Northrop Grumman Corp., L3Harris, and BAE Systems.

Although initial AOEW prototypes are to be installed on MH-60R and MH-60S helicopters, future deployable versions may be intended for long-range, long-endurance fixed-wing or helicopter unmanned aerial vehicles (UAVs), experts say.

Lockheed Martin will develop a modular open-systems architecture (MOSA)

to enable the EW payload to adapt to evolving threats, hasten deployment, reduce development time and costs, and facilitate future system upgrades and technology insertion.

The AOEW program capitalizes on Lockheed Martin expertise across the corporation. The Lockheed Martin facility in Owego, N.Y., will integrate the system onto the MH-60 helicopters, which are built by Sikorsky, a Lockheed Martin company in Stratford, Conn. ←



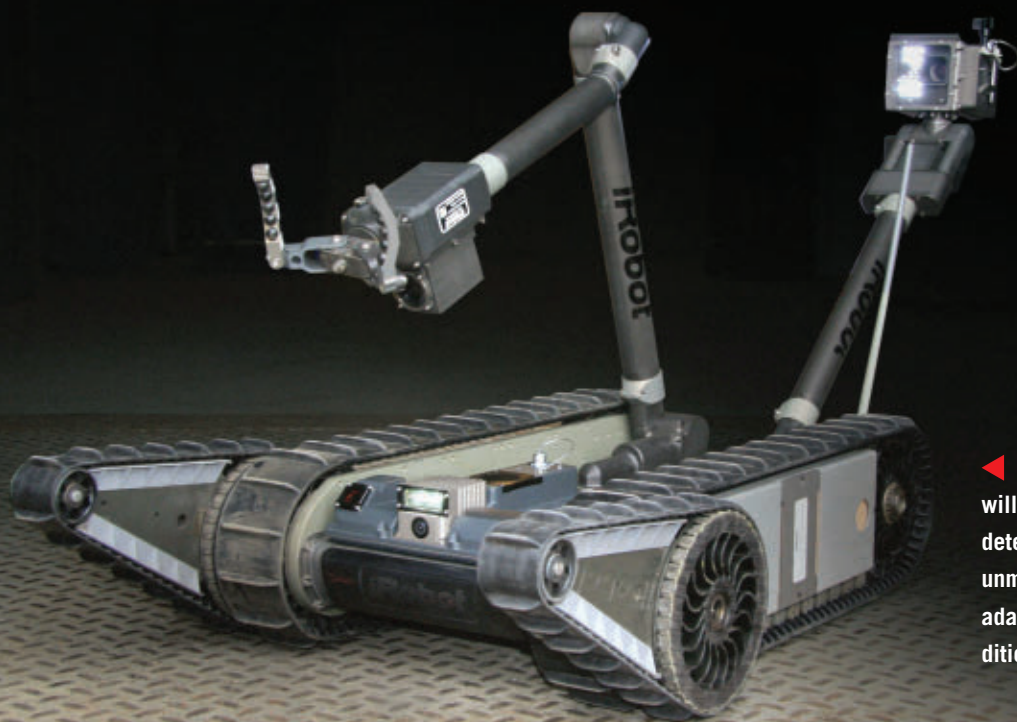
▲ **The AN/ALQ-248 AOEW will provide long-endurance, off-board electronic countermeasures against anti-ship missiles with a long-duration EW payload for the MH-60R and MH-60S ship-based maritime helicopters.**

Officials of the Naval Sea Systems Command in Washington has announced a \$17.8 million order to the Lockheed Martin Rotary and Mission Systems segment in Liverpool, N.Y., to build low-rate initial production units of the AN/ALQ-248 Advanced Off-Board Electronic Warfare (AOEW) Active Mission Payload (AMP) system for the MH-60R and MH-60S ship-based maritime helicopters. Lockheed Martin will deliver as many as 18 AOEW AMP AN/ALQ-248 pods.

AOEW will provide long-endurance, off-board electronic countermeasures against current and future anti-ship missile threats with a long-duration EW active mission payload for the MH-60R and MH-60S ship-based maritime helicopters.

The AOEW AMP AN/ALQ-248 can work independently

On this order Lockheed Martin will do the work in Syracuse, N.Y.; Lansdale, Pa.; Stratford, Conn.; and Orlando, Fla., and should be finished by May 2024. For more information contact Lockheed Martin Rotary and Mission Systems online at [www.lockheedmartin.com](http://www.lockheedmartin.com), or Naval Sea Systems Command at [www.navsea.navy.mil](http://www.navsea.navy.mil).



◀ The iRobot PackBot will help researchers determine ways to help unmanned ground vehicles adapt to unforeseen conditions and events.

# AI to enable manned and unmanned vehicles adapt to unforeseen events like damage

BY John Keller

**ARLINGTON, Va.** — U.S. military researchers are asking industry to develop artificial intelligence (AI) systems that respond well to conditions and events that these systems have never seen before.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have released a presolicitation (HR001121S0036) for the Learning Introspective Control (LINC) project.

LINC aims to develop AI- and machine learning-based technologies that enable computers to examine their own decision-making processes in enabling military systems like manned and unmanned ground vehicles, ships, drone swarms, and robots to respond to events not predicted at the time these systems were designed.

LINC technologies will update control laws in real time while providing guidance and situational awareness to the operator, whether that operator is human or an autonomous controller.

Today's control systems seek to model operating environments expected at design time. Yet these systems can fail when they encounter unexpected conditions and events.

Instead, LINC will develop machine introspection and learning technologies that can characterize unforeseen circumstances like a damaged or modified military platform from its behavior, and then update the control law to maintain stability and control.

A LINC-equipped platform will compare the behavior of the platform, as measured by on-board sensors, continually with a



learned model of the system, determine how the system's behavior could cause danger or instability, and implement an updated control law when required.

This could be an improvement of today's approaches to handling platform damage, which places the burden of recovery and control on the operator, whether that operator is human or an autonomous controller.

LINC will help operators maintain control of military platforms that suffer damage in battle or have been modified in the field in response to new requirements. LINC-enabled control systems will build models of their platforms by observing behavior, learning behavioral changes, and modifying how the system should respond to maintain uninterrupted operation.

LINC should be able to detect disruptive changes in control response and quickly develop a control regime based not only on the learned model, but also on changes that take place after the model has been learned.

LINC focuses on two technical areas: learning control by using onboard sensors and actuators; and communicating situational awareness and guidance to the operator.

Learning control by using onboard sensors and actuators will perform cross-sensor data inference to characterize changes in system operation, rapidly prune possible solutions to reconstitute control under changed dynamics, and identify an area of nondestructive controllability by continually recalculating operating limits.

Communicating situational awareness and guidance to the operator involves informing the operator of changes in system behavior in a concise, usable form by developing technologies to provide guidance and operating cues that convey details about the new control environment and its safety limitations.

LINC will be a four-year, three-phase program; the first phase will last for 18 months, and the second and third phases will last for 156 months each.

Initial work will involve an iRobot PackBot and a remote 24-core processor. This ground robot weighs 20 pounds; measures 26.8 by 15.9 by 7.1 inches; has tracked and untracked flip-pers; moves at 4.5 miles per hour, and operates in temperatures from -20 to 50 degrees Celsius.

The remote processor has an Nvidia Jetson TX2 general-purpose graphics processing unit (GPGPU), dual-core NVIDIA Denver central processor, Quad-Core ARM Cortex-A57 MPCore processor; 256 CUDA software cores, eight gigabytes of 128-bit LPDDR4 memory, and 32 gigabytes of eMMC 5.1 data storage.

A key goal of the program is to establish an open-standards-based, multi-source, plug-and-play architecture that allows for interoperability and integration. ◀

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Companies interested were asked to upload proposals to the DARPA BAA website by 26 Oct. 2021 at <https://baa.darpa.mil>. Several awards are expected. Email questions or concerns to DARPA at [LINC@darpa.mil](mailto:LINC@darpa.mil). More information is online at <https://sam.gov/opp/5103486731854edeb65992a7495f3408/view>.

### Marines look to unmanned underwater vehicles for bomb-disposal missions

In the past, Marine divers had to swim long distances at limited depths, as they searched for underwater explosive hazards in close proximity. Traditionally, this was the only way to dispose or disrupt underwater threats — a highly risky exercise. Enter the explosive ordnance disposal remotely operated vehicle (ROV), a next-generation box-shaped amphibious unmanned robot that enables Marines to support shallow-water operations globally. The ROV employs sound navigation and ranging (SONAR) sensors, high-definition video, and cameras that provide real-time feedback for bomb-disposal divers.

### Lockheed Martin and Verizon collaborate on 5G to connect military datalinks

The world's largest defense contractor is working with the largest wireless provider in the United States to develop technology for a military 5G mobile network. The agreement

between Lockheed Martin Corp. and Verizon comes after the two companies linked a commercial 5G mobile wireless network with a military communications network used by fighter jets to send and receive targeting coordinates. The test's secret sauce is a special Lockheed-made communications gateway that enables the two networks to connect to one another. In many cases, military weapons use disparate military datalinks, which are specialized modems that cannot connect to one another. The gateway acts as a translator between these different networks. The Lockheed-Verizon agreement is largely focused on research-and-development, but it could expand in the future.

### Navy jet fighters and unmanned vehicles could create carrier-based ASW capability

A recent proposal penned by Navy and Marine Corps personnel for the U.S. Naval Institute in Annapolis, Md., breaks down how the Navy quickly and cheaply *Continued on page 36*

# Hydroid to upgrade sensors on Navy MK 18 Mod 2 unmanned underwater vehicle (UUV)

BY John Keller

**NEWPORT, R.I.** — U.S. Navy mine-countermeasures experts are asking Hydroid Inc. in Pocasset, Mass., to design enhanced undersea sensors to enhance the ability of the MK 18 Mod 2 Kingfish unmanned underwater vehicle (UUV) to detect and pinpoint buried undersea mines.

Officials of the Naval Undersea Warfare Center Division in Newport, R.I., announced a \$74.7 million contract to Hydroid in April for MK 18 Mod 2 UUV Increment II Payload Upgrade hardware in support of the existing MK 18 Mod 2 UUV program.

The MK 18 Mod 2 Kingfish is a medium-to-heavyweight UUV designed to detect, locate, and map floating, moored, or buried sea mines in relatively shallow waters. It is a larger version of the MK-18 Mod 1 Swordfish, which is based on the Hydroid Remote Environmental Monitoring System (REMUS) 100 unmanned submersible.

Navy experts asked Hydroid to increase the size of the MK 18 MOD 2 Kingfish to enhance the UUV's power and onboard sensor capacity. Hydroid engineers increase the UUV's size simply by scaling-up the MK-18 Mod 1 design.

Navy experts are asking Hydroid to upgrade the MK 18 Mod 2 sensor and sensor-processing suite to enhance its ability to find and pinpoint mines in murky water or in other kinds of difficult environmental conditions like mud and sand.

The current MK-18 Mod 2 design has a dynamic-focus side-look sonar; conductivity and temperature sensor; beam attenuation meter optical sensor; pencil beam sonar for obstacle avoidance; and fluorometer and turbidity measurement sensors.

The MK 18 Mod 2 UUV is deployable from an 11 meter rigid-hull inflatable boat (RHIB). It is 12.75 inches in diameter, 11.5 feet long, and weighs about 600 pounds.

In addition to its mine-hunting sensors and onboard sensor processing, the MK 18 Mod 2 UUV has acoustic communications, Iridium satellite communications (SATCOM), and radio modem.



**Hydroid engineers will upgrade the sensors and signal processing aboard the Kingfish unmanned submersible to enhance its mine-hunting capabilities.**

The UUV navigation system consists of an up- and down-looking acoustic Doppler current profiler; Doppler velocity log; inertial navigation unit; compass; and P-code Global Positioning System (GPS). ◀

On this contract Hydroid will do the work in Pocasset, Mass., and should be finished by April 2026. For more information contact Hydroid online at [www.hydroid.com](http://www.hydroid.com), or the Naval Undersea Warfare Center Division-Newport at [www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport](http://www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport).

# Navy orders 15 ScanEagle unmanned aircraft, sensor payloads, and video data links

BY John Keller

LAKEHURST, N.J. — U.S. Navy unmanned aircraft experts are buying 15 small reconnaissance unmanned aerial vehicles (UAVs) and onboard sensor payloads for Afghanistan under terms of a \$9.8 million contract.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., are asking Boeing Insitu Inc. in Bingen, Wash., to provide 15 ScanEagle UAVs for Afghanistan National Army intelligence, surveillance, and reconnaissance (ISR).

The Boeing Insitu ScanEagle UAV is 5.1 feet long with a 5.6-foot wingspan. It weighs as much as 48.5 pounds and can carry a 7.5-pound sensor payload. The UAV can fly for more than 24 hours at altitudes as high as 19,500 feet, and at speeds to 80 knots.

The ScanEagle UAV can fly on gasoline or heavy fuels like jet fuel, diesel, or kerosene. It provides persistent surveillance and reconnaissance imagery on land or at sea at lower costs than other surveillance methods for military and agriculture missions.

ScanEagle can carry a sensor payload consisting of visible-light camera, medium-wave infrared imager, or both integrated in one turret. The UAV also has an analog dig-



**The U.S. Navy is ordering 15 ScanEagle reconnaissance unmanned aerial vehicles (UAVs) and onboard sensor payloads for Afghanistan.**

itally encrypted video data links, as well as encrypted or unencrypted command-and-control data links.

The UAV can be launched autonomously and uses a no-nets recovery system that recovers with its wing tip on a rope that hangs from a boom. ←

On this contract Insitu will do the work in Bingen, Wash., and should be finished by July 2021. For more information contact Boeing Insitu online at [www.insitu.com](http://www.insitu.com), or the Naval Air Warfare Center Aircraft Division at [www.navair.navy.mil/nawcad](http://www.navair.navy.mil/nawcad).

*Continued from page 34* could turn its carrier-based jet fighters into anti-submarine warfare (ASW) weapons. With new weapons designed to engage submerged vessels, jet fighters could become dynamic submarine hunters using onboard sensors to detect submerged vessels and deploying specialized munitions to eliminate them. Using unmanned aircraft and underwater vehicles would detect a submarine, follow it as it attempts to flee, and keep the carrier strike group and nearby ASW aircraft apprised of the submarine's location. Navy fighters could use aerial iterations of the Mk-54 lightweight torpedo or the Compact Rapid Attack Weapon (CRAW) torpedoes currently deployed by surface ships.

## Marines test backpackable EW payload on unmanned aerial vehicle (UAV) deployed at sea

U.S. Marines aboard the amphibious transport dock USS New Orleans have launched a portable electronic warfare (EW) system on a drone aircraft for the first time at sea. A backpackable electronic attack module uses its technology to detect the radio frequency of a specific threat — a hostile unmanned aerial vehicle, for example — locate it and take it out, according to the Marine officer in charge of the 10 Marines and sailors taking part. "It is set apart from other systems because of its ease of use," says Marine Capt. Jesse Schmitt, assistant intelligence officer for the 31st Marine Expeditionary Unit. ←



# Two companies to develop mission planning autonomy for manned-unmanned teaming

BY John Keller

**WRIGHT-PATTERSON AFB, Ohio** — U.S. Air Force researchers are looking to two companies to develop enabling technologies to help automate air force missions from the planning stages to post-mission analysis.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have awarded contracts to Systems & Technology Research LLC Woburn Mass.; and to RBR Technologies in Odenton Md., for the Science and Technology for Autonomous Teammates (STAT) program.

The STAT program seeks to develop and demonstrate machine autonomy technologies for multi-domain command and control; intelligence, surveillance, recognition, and processing exploitation, and dissemination; and manned/unmanned combat teaming through human-machine teaming and autonomous decision making.

Systems & Technology Research won an \$8.9 million contract on 17 Aug. 2021, and RBR Technologies won an \$8.3 million contract on 9 July 2021 for the STAT program.

This project should result in technology demonstrations that could improve the Air Force's capability to conduct missions in different environments while minimizing the risks to airmen, and enable the Air Force to operate inside of the enemy's decision loop, researchers say.

STAT will develop and apply autonomy technologies to enhance mission planning, mission execution, and post-mission analysis. The project emphasizes multi-domain command and control, manned-unmanned teaming, and information analytics.

This effort will demonstrate modular, transferable, open-systems autonomy architectures with software algorithms that will ingest and understand mission taskings and commander's intent; respond appropriately to human direction and orders; and respond intelligently to dynamic threats and unplanned events.

Technologies will enable airman-machine teaming to reduce workloads without compromising mission effectiveness or dead-lines; enable autonomous systems to understand a commander's



**The Air Force is trying to develop new kinds of mission-planning technologies to enhanced teaming among humans and unmanned systems.**

mission requirements and adapt to changing circumstances; and enable autonomous and unmanned systems to integrate safely and efficiently into Air Force operations.

The STAT project revolves around eight research areas: mission planning and debrief; flight operations; communications and datalinks; human interfaces; multi-domain mission operations; executive functions; systems integration; and test and evaluation. ◀

For more information contact Systems & Technology Research online at [www.str.us](http://www.str.us), RBR Technologies at [www.rbr-technologies.com](http://www.rbr-technologies.com), or the Air Force Research Laboratory at [www.afrl.af.mil](http://www.afrl.af.mil).

The EOSS electro-optics system is a check sight and targeting sensor for anti-surface and anti-air warfare and naval gun fire support missions aboard Navy surface warships.

# L3Harris to build electro-optical gun sights for Navy surface warships

BY John Keller

WASHINGTON — Military electro-optics experts at L3Harris Technologies Inc. will provide shipboard gun sights for the fire-control necessary for U.S. Navy and Coast Guard warships to hit enemy ships and aircraft with naval gun fire under terms of a potential \$54.2 million seven-year contract.

Officials of the Naval Sea Systems Command in Washington are asking the L3Harris KEO segment in Northampton, Mass., to produce additional MK 20 electro-optical sensor systems (EOSS), radar cross sections kits, shock ring kits, and spare parts for the Navy and Coast Guard.

The EOSS electro-optics system is a check sight and targeting sensor for anti-surface and anti-air warfare and naval gun fire support missions aboard Navy destroyers, cruisers, and Coast Guard vessels, Navy officials say.

The MK 20 EOSS is a major component of the MK 34 5-inch guns aboard Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers, as well as aboard the U.S. Coast Guard Offshore Patrol Cutter, for use against enemy ships, boats, and aircraft.

L-3 KEO has been building the EOSS since 2005. That year L3-KEO won a Navy contract to provide the EOSS for the Ticonderoga-class Cruiser Modernization Program. Company

electro-optical engineers built on the MK 46 Optical Sight System to blend new technologies into the MK 20 shipboard MOD 0 EOSS, as well as integrate the system into the MK 34 5-inch deck guns.

The MK 20 EOSS has digital stabilization with fiber-optic gyros, a separate eye-safe laser rangefinder with diode-pumped laser, enhanced built-in test, and improved sensor-to-sensor boresight alignment. The EOSS meets MIL-S-901D heavy-weight and large-displacement shock tests.

The MK 20 MOD 0 incorporates several technology improvements over the MK 46, and new features that support integration with the MK 34 Gun Weapons System (GWS).

To integrate with the MK 34 deck gun, the EOSS has a new interface electronics unit (IEU) that interfaces with as many as two deck gun computers and three deck gun consoles to provide video, target bearing and range, and system status data to all three, while taking commands from any one, L3Harris officials say. ◀

The initial contract is for 18.4 million and extends through September 2024. The contract has options that could increase its value to \$54.2 million and extend to September 2028. For more information contact L3Harris KEO online at [www.l3harris.com/all-capabilities/naval-platform-imaging](http://www.l3harris.com/all-capabilities/naval-platform-imaging), or Naval Sea Systems Command at [www.navsea.navy.mil](http://www.navsea.navy.mil).

### Marines eye DARPA OpFires hypersonic missile to target enemy ships from Pacific islands

U.S. military researchers are teaming up with Lockheed Martin Corp. to develop an intermediate-range, ground-launched hypersonic weapon called OpFires or Operational Fires. OpFires would mate a new variable-range hypersonic missile with mobile ground-based weapons that could attack valuable time-critical targets on land and at sea. The project actually an important revolution in hypersonic missile design. What makes this project particularly difficult — and therefore within DARPA's purview — is that this hypersonic rocket will be throttleable. U.S. Marines are training to perform an extremely rapid infiltration and exfiltration on enemy-held islands in the Pacific. Once secure, Air Force transports could land and unload OpFires-equipped HIMARS long-range rocket artillery to target enemy ships.

### Space Force sends wish list to Congress that includes surveillance satellites

The U.S. Space Force is asking Congress for \$832 million over its \$17.4 billion budget request for its unfunded priority list — an annual wish list of spending every service sends lawmakers. The request sent June 3 to Congress includes additional funding for dozens of programs, repairs to Space Force facilities, and \$279 million in classified spending to develop a war fighting punch. The Space Force wish list sets aside \$113 million to grow new missions. That includes \$28 million toward radio frequency payloads for the Defense Advanced Research Projects Agency's Blackjack program, which seeks to demonstrate the utility of a proliferated constellation of networked satellites in low Earth orbit for the military. With this request, Space Force would test new space-based intelligence, surveillance and reconnaissance capabilities on orbit in fiscal 2022 and 2023 to inform future investment. Space Force leaders have stated in recent months that it needs to develop a tactical ISR mission, which could involve building out its own constellation of imagery satellites.

### Chinese ability to use laser weapons to defeat GPS satellites a growing concern

China's space weapons include missiles and killer satellites, but Beijing's most worrying arms are lasers and electronic jammers capable of destroying or disrupting Global Positioning System navigation satellites used by the U.S. military, the general in charge of space says. U.S. Air Force Gen. John W. Raymond, chief of space operations for the Pentagon's new Space Force, and other Air Force officials have told Congress that the U.S. military needs to move quickly to counter increasingly aggressive

Chinese and Russian moves in space that involve laser weapons and electronic jammers. Both are building weapons designed to engage in "robust jamming of GPS and communications satellites," as well as "directed-energy systems that can blind, disrupt or damage our satellites," Raymond testified to the House Appropriations defense subcommittee. When asked of Pentagon and intelligence community reports that China is deploying ground-based lasers that can destroy GPS satellites and other spacecraft circling the globe in low-Earth orbit, the general told lawmakers the "threat is real today and concerning."

### Air Force UAV pilots use virtual reality for training and mission rehearsal

The U.S. Air Force has started using virtual reality to get hunter-killer unmanned aerial vehicle (UAV) pilots and sensor operators up to speed at Holloman Air Force Base, N.M. Trainees at the base have begun using Oculus Quest 2 headsets that enable them to simulate being in a unmanned aircraft cockpit, and watching instructors remotely pilot an MQ-9 Reaper aircraft, Air Force officials say. Reapers, made by General Atomics of San Diego, can carry 3,000 pounds of bombs and missiles, and first saw combat in Afghanistan in 2007 and Iraq the following year. They've conducted missions there and in other parts of the Middle East and Africa. The virtual reality technology powering the Reaper training is from Moth + Flame, a Brooklyn, N.Y.-based company that has worked with the Air Force since 2019. ◀

### Navy arms Burke-class destroyer with laser optical dazzler weapon

According to a picture released on the Twitter account of the U.S. Navy, the USS Stockdale (DDG-106), an Arleigh Burke-class Flight IIA guided missile destroyer, has been armed with a laser weapon named ODIN. The Navy in recent years has leveraged significant advancements in industrial solid-state lasers (SSLs) and decades of research on military lasers on U.S. Navy surface ships. Optical Dazzler Interdictor Navy (ODIN) development provides near-term, directed energy, shipboard counter-intelligence, surveillance, and reconnaissance (C-ISR) capabilities to dazzle unmanned aircraft. ODIN can stymie enemy drones threatening surface ships. And now it's installed aboard an active destroyer. ODIN already is installed on three U.S. Navy Arleigh Burke-class guided-missile destroyers and will be installed on two more this year and three more in the coming years, for a total of eight destroyer surface warships that will help test out the system during the course of their training and operations.

*Continued on page 41*





# Electro-optical rifle sight that uses AI and augmented reality introduced by Elbit

BY John Keller

**HAIFA, Israel** — Elbit Systems in Haifa, Israel, is introducing the ARCAS built-in computerized rifle-sight system that uses artificial intelligence (AI) to give infantry assault rifles digital networking capability during the day and at night.

ARCAS interfaces with the rifle's electro-optical sight, with a helmet-mounted eyepiece, and with the rifle's assemblies to provide warfighters soldiers with real-time intuitive actionable combat information.

The ARCAS rifle sight provides passive range measurement; automatic ballistic correction; detection of fire sources; video motion detection; the ability to shoot around the corner and from the hip; interfaces with tactical command and control; navigation assistance; friend or foe identification; tracking of stoppage and ammunition; and weapon zeroing without the need for live fire.

An AI-powered computer that integrates into the rifle's

▲ **ARCAS interfaces with the rifle's assemblies to provide warfighters with real-time intuitive actionable combat information.**

forward grip runs software applications. The sight receives and processes data from the soldier's field of view, tactical information from command-and-control systems, data from other ARCAS users, and the rifle's mechanical information.

This information goes to the user as an augmented reality layer on top of the scenery seen through the electro-optical sight or the helmet-mounted eyepiece. Soldiers operate the system using a joystick button on the rifle's forward grip. ◀

ARCAS has thermal or low-light configurations, and can run third-party applications. For more information contact Elbit Systems online at <https://elbitsystems.com>.

# Raytheon to help protect missile submarines with signature modeling technologies

BY John Keller

**ARLINGTON, Va.** — Underwater warfare experts at Raytheon Technologies Corp. will develop new ways of protecting the U.S. nuclear ballistic missile submarine that do not involve sound or sonar under terms of a \$9.5 million contract.

Officials of the U.S. Office of Naval Research (ONR) in Arlington, Va., are asking the Raytheon Missiles & Defense segment in Portsmouth, R.I., to pursue the Science and Technology Research for the SSBN Security Technology Program (SSTP) program, also referred to as Oban 3.

Raytheon researchers will investigate physics-based non-acoustic phenomenologies of nuclear ballistic missile submarine security, and develop new products in signature modeling and validation, clutter modeling and validation, signal processing algorithms, and countermeasure concepts.

The goal is to improve the survivability of U.S. ballistic missile submarines — particularly before they have time to fire their weapons, by gaining knowledge of threats to submarines that involve underwater detection, tracking, and engagement.

Non-acoustic submarine protection involves submarine-induced hydro-dynamic signature generation, propagation, and decay models of submarine hydrodynamic wakes, and detecting submarine masts and periscopes with radar.

Other non-acoustic submarine-protection approaches can involve AC and DC electromagnetic signature measurements on submerged submarines; detecting submarine wake signatures



**The goal is to improve the survivability of U.S. ballistic missile submarines by gaining knowledge of threats that involve underwater detection, tracking, and engagement.**

on the ocean's surface with infrared sensors and optics; detecting bioluminescence patterns; and detecting submarine hulls with airborne laser radar (ladar).

New approaches are possible that involve understanding the physical phenomenology of submarine detection and tracking; characterizing the natural ocean environment; and anti-submarine warfare (ASW) tactical decision aids. ←

On this contract Raytheon will do the work in Portsmouth, R.I., and should be finished by August 2024. For more information contact Raytheon Missiles & Defense online at [www.raytheonmissilesanddefense.com](http://www.raytheonmissilesanddefense.com).

*Continued from page 39*

## U.K. Tempest sixth-generation jet fighter moves forward with contract awards

Britain's Tempest sixth-generation fighter jet is a step closer to reality after the United Kingdom Ministry of Defence (MOD) awarded BAE Systems a contract for \$348 million to begin the program's concept and assessment phase. The cornerstone of Britain's Future Combat Air System, the Tempest jet fighter is being developed by the MOD, BAE Systems, Leonardo UK, MBDA UK, and Rolls-Royce under a trilateral agreement with Italy and Sweden. When it enters service in 2035, it will work

alongside the Typhoon Eurofighter and the Lockheed Martin F-35 Lightning II Joint Strike Fighter, before eventually replacing them in the 2040s. Under the new contract, the consortium will create the tools and techniques required to develop and assess the final design and capability specifications for the aircraft. The twin-engine, delta-wing Tempest will include artificial intelligence, machine learning, and autonomous systems, which allow the craft to act as a flying command and control center while the pilot acts as an executive officer rather than a dogfighter. In addition, Tempest will have abundant surplus electrical power that will allow it to carry hypersonic missiles, control drone swarms, and run laser weapons. ←



# PRODUCT APPLICATIONS

## SENSORS

### ► Researchers choose FLIR to develop electro-optical chemical-detection sensors

U.S. military experts involved in counter-ing weapons of mass destruction needed next-generation chemical detection technology. They found their solution from FLIR Systems Inc. in Wilsonville, Ore.

Officials of the Defense Threat Reduction Agency's Joint Science and Technology Office (DTRA JSTO) in Arlington, Va., have announced a contract potentially worth \$8 million to FLIR Systems for chemical-detection technologies based on ion mobility spectrometry (IMS) and mass spectrometry (MS) technology.

FLIR will team with Purdue University in West Lafayette, Ind. to develop ion mobility design and two-dimensional mass spectrometry (2D MS/MS) into a modular chemical-detection system.

It will be lightweight enough for one person to carry that can screen downrange areas for the presence of harmful chemicals. The system will function as a sensor payload for unmanned vehicles, and as an embedded real-time monitor for chemical releases.

The program's goal is to provide warfighters with small, fast, interconnected chemical detection and identification tools for a wide range of scenarios.

Experts from FLIR and Purdue will work together to develop chemical-detection sensors that collect large amounts of data from one sample and remove the need for pre-recorded data libraries of known threats.

Advanced algorithms will enable analysts to identify and classify never-before-seen threats with modular front-ends



and options for communication protocols and power inputs for a broad range of detection missions.

The three-year effort will result in a mature integrated IMS/MS prototype ready to move into military programs of record, experts say. FLIR and Purdue will do the work in West Lafayette, Ind.

For more information contact FLIR Systems online at [www.flir.com](http://www.flir.com), Purdue University at [www.purdue.edu](http://www.purdue.edu), or DTRA JSTO at [www.dtra.mil](http://www.dtra.mil).

## TEST AND MEASUREMENT

### ▼ Ametek to assemble open-architecture avionics test and measurement stations

U.S. Air Force electronics experts needed a company to assemble a field- and depot-level avionics test and measurement system. They found their solution from Ametek Programmable Power Inc. in San Diego.

Officials of the Air Force Sustainment Center at Robins Air Force Base, Ga., announced a \$15.7 million five-year contract to Ametek on Monday to provide kits to assemble the Versatile Diagnostic Automatic Test Station (VDATS).

VDATS is the Air Force member of the U.S. military families-of-testers, and is the Air Force's directed and preferred automatic test solution for avionics.

Ametek Programmable Power joins Rohde & Schwarz USA Inc. in Columbia, Md.; Teradyne Inc. in North Reading, Mass.; and Keysight Technologies Inc. in Colorado Springs, Colo., in assembling VDATS test





stations. TFAB Defense Systems LLC in Warner Robins, Ga., also is maintaining, upgrading, and assembling VDATS systems.

VDATS supports the avionics and other electronics for the A-10, B-1, B-2, B-52, C-5, C-17, C-130, E-3, E-8C, F-15, F-16, F-22, H-53, H-60, UH-1, and KC-135 aircraft; the MC-4 and MQ-9 unmanned aerial vehicles (UAVs); and Navy ships.

The VDATS design enables modular capability enhancements through mission equipment support sets (MESS) for small applications or roll-up bays for larger applications that are portable.

This preserves the configuration stability of the station while providing flexibility to adapt to a wide variety of workload requirements, which also reduces the proliferation of unique test stations, experts say.

On this contract Ametek will do the work in San Diego, and should be finished by April 2026. For more information contact Ametek Programmable Power online at [www.powerandtest.com](http://www.powerandtest.com); Rohde & Schwarz USA Inc. at [www.rohde-schwarz.com](http://www.rohde-schwarz.com); Keysight Technologies at [www.keysight.com](http://www.keysight.com); Teradyne at [www.teradyne.com](http://www.teradyne.com); TFAB Defense Systems at [www.tyonek.com/business-services/manufacturing/tfab-defense-systems](http://www.tyonek.com/business-services/manufacturing/tfab-defense-systems); or the Air Force Sustainment Center at [www.afsc.af.mil](http://www.afsc.af.mil).

#### SENSOR COMPONENTS

### ► Northrop to provide components for LAIRCM aircraft missile-defense system

Aircraft missile-defense experts at Northrop Grumman Corp. will provide electronic parts necessary to build a laser defense system to protect large military aircraft from infrared heat-seeking missiles.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced a \$115.5 million order to the Northrop Grumman Mission Systems segment in Rolling Meadows, Ill., to procure the necessary weapon replaceable assemblies, systems engineering technical support, analysis, and studies to integrate the Large Aircraft Infrared Countermeasures (LAIRCM) system onto aircraft for the U.S. Navy, Air Force, and the government of Australia.

LAIRCM automatically detects a missile launch, determines if it is a threat, and activates a high-intensity laser-based

countermeasure system to track and defeat the missile, Northrop Grumman officials say.

The system is for large aircraft like the U.S. Navy P-8A Poseidon maritime patrol jet and the Marine Corps CH-53 Super Stallion large helicopter. LAIRCM also can go aboard the U.S. Air Force C-5, C-17, C-37, and C-40 cargo and utility jets; C-130H and MC-130W four-engine utility turboprop aircraft, the CV-22 tiltrotor aircraft, and the KC-46 aerial refueling jet.

The order asks Northrop Grumman to provide 228 advanced threat warning sensors; 79 control indicator unit replaceable; 25 2103 signal processors; 54 infrared missile warning sensors; 101 Guardian laser transmitter assemblies; seven multi-role electro-optical end-to-end test sets; 83 shipping containers; 60 high capacity cards; nine large aircraft system processor replacement smart connector assemblies; and 282 personal computer memory card international association cards for the Navy.

The order also asks the company to provide 65 advanced threat warning sensors; three control indicator unit replaceable units; six Guardian laser transmitter assemblies; 12 high capacity cards; and six large aircraft system processor replacement smart connector assemblies for the Air Force; two Guardian laser transmitter assemblies; 12 infrared missile warning sensors; two shipping containers; and two large aircraft system processor replacement smart

connector assemblies for the government of Australia.

LAIRCM focuses its high-intensity laser energy at the infrared seeker head of incoming missiles to blind the missile and force it off its target. The system is designed to protect large aircraft from shoulder-fired, vehicle-launched, and other infrared-guided missiles when the planes are operating close to the ground, such as during takeoffs, landings, and low-level operations like aerial refueling.

On this order Northrop Grumman will do the work in Rolling Meadows, Ill.; Goleta, Calif.; Longmont, Colo.; Columbia, Md.; and other locations, and should be finished by June 2023.

For more information contact Northrop Grumman Mission Systems online at [www.northropgrumman.com](http://www.northropgrumman.com), or Naval Air Systems Command at [www.navair.navy.mil](http://www.navair.navy.mil). ◀



## CONNECTORS

### ► Rugged contacts for connectors for harsh-environment uses introduced by Amphenol

Amphenol Industrial Operations in Endicott, N.Y., is introducing the high speed Quadrax contacts that can be implemented in Amphenol's GT series connectors and used in hazardous environments. Quadrax contacts offer more reliable rail mass transit (RMT) application requirements on inter-vehicle connections and database applications than multi-pole connectors without individual shielding. This combination of a reverse bayonet connector and Quadrax contacts results in a connector that offers one outer contact with four inner contacts spaced to form two 100- to 150-Ohm controlled impedance differential pairs. The GT Quadrax is an alternative to the more expensive DTL-38999 Series III and ARINC-type connectors for harsh-environment applications, including Ethernet 100 Bas-T-100 Ohm, Gigabit Ethernet 1000 Base-T-100 Ohm, Fiber Channel-150 Ohm, and IEEE 1394B FireWire-110 Ohm. These connector contacts are for factory automation, control devices, and railroad rolling stock. The contacts feature high EMI shielding performance, reverse bayonet locking for ease of use, high shock and vibration resistance, as many as 500 mating cycles, and quick positive coupling. For more information contact Amphenol Industrial Operations online at [www.amphenol-industrial.com](http://www.amphenol-industrial.com).



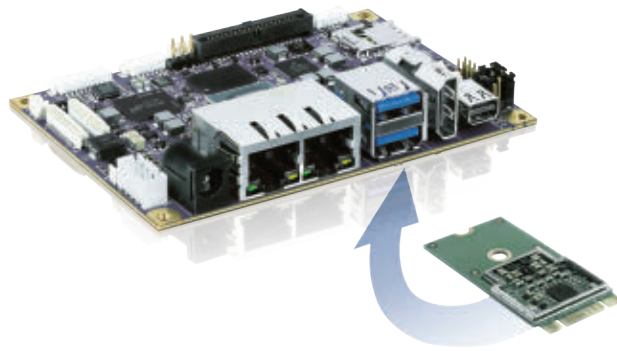
stations. Systems designers can use the loop-back test signals for accurate and reliable testing of RF signals. The Quad band Satellite Simulator makes it easy to test several frequencies, and can test as many as four ground terminals at the same time. Housed in a

weatherproof IP65 rated enclosure, the Quad band Satellite Simulator is for ground terminals, VSAT Testing, bent-pipe testing mobile ground terminals, integration, EMI testing, telemetry, and airborne monitoring receiving systems. For more information contact Atlantic Microwave online at [www.atlanticmicrowave.com](http://www.atlanticmicrowave.com).

## BOARD PRODUCTS

### ▼ 3U VPX graphics board for military AI and deep learning introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the GRA115Q 3U VPX graphics output card for military and aerospace graphics generation, display computing, situational awareness, high-performance computing, artificial intelligence (AI), and deep learning. The GRA115Q is for new and legacy systems that require increased graphics processing unit (GPU) performance while offering several configurations with relatively low overall system size, weight, power consumption, and cost (SWaP-C). The GRA115Q offers the discrete NVIDIA Turing architecture GPUs with either the Quadro RTX 5000 or the Quadro RTX 3000 GPU and increases performance by as much as 4x over NVIDIA Pascal-class GPUs, company officials say. This product supports cutting-edge signals intelligence (SIGINT), situational awareness, radar, video, and graphics applications by offering three different output configurations. It offers



## SATELLITE COMMUNICATIONS

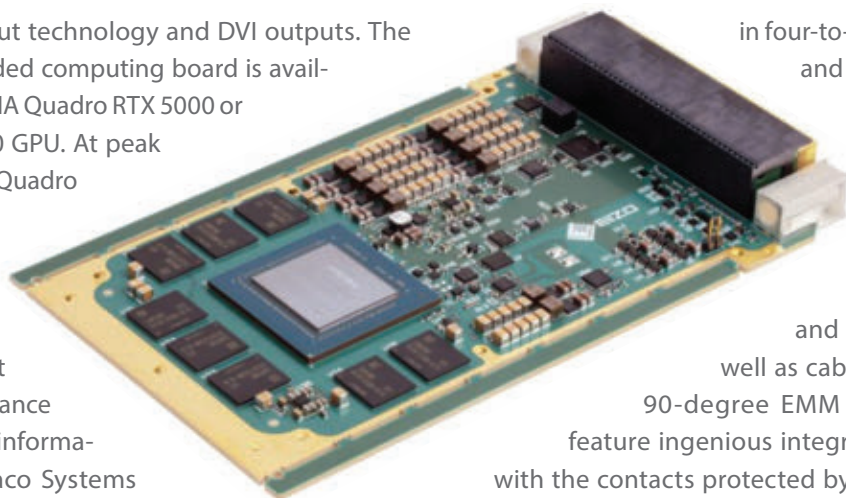
### ▼ Simulator for testing SATCOM at Earth stations introduced by Atlantic Microwave

Atlantic Microwave Ltd. in Braintree, England, is introducing the Quad band Satellite Simulator designed to meet the rising demand for several RF frequency satellite communications (SATCOM) testing at satellite Earth stations. The Quad

band Satellite Simulator provides loop-back testing for frequency bands C, X, Ku, and Ka simultaneously to enable Earth station setup without the need for connectivity to a satellite. The simulator is suitable for testing several bands and ground



DisplayPort output technology and DVI outputs. The GRA115Q embedded computing board is available with an NVIDIA Quadro RTX 5000 or Quadro RTX 3000 GPU. At peak performance, the Quadro RTX 5000 provides as much as 9.49 TFLOPS of single precision floating point compute performance (FP32). For more information contact Abaco Systems online at [www.abaco.com](http://www.abaco.com).



in four-to-60 pin-configurations, and are modular, suited to board-to-board and board-to-wire configurations, with male and female thru-hole and SMT straight and 90-degree variants as well as cabled versions available.

90-degree EMM series interconnects feature ingenious integrated back protection, with the contacts protected by a proprietary design. Hardware is interchangeable, with locking and guiding functions available on both male and female connectors to ensure no misalignment or mis-mating can occur. Manufactured in Nicomatic's facility in France, EMM series rugged connectors have high-performance glass fiber composite molding, copper alloy male pins and female pins featuring tulip technology — a clip with a four-finger spring contact made with the outer in copper alloy and beryllium copper inner. Fixing hardware is passivated 300-series stainless steel. EMM interconnects can be mated and unmated up to 500 times. Electrical performance is rated voltage of 250 volts RMS at sea level, dielectric withstanding voltage 750 volts RMS. For space applications, they are certified to meet the ASTM E595 (ECSS-Q-ST-70-02C) specification for thermal vacuum outgassing. For more information contact Nicomatic online at [www.nicomatic.com](http://www.nicomatic.com).

#### GRAPHICS PROCESSING

##### ▲ **Embedded computing kit for graphics data processing introduced by Kontron**

Kontron Europe GmbH in Ismaning, Germany, is introducing the Google Coral Edge Tensor Processing Acceleration Unit (TPU) with as much as 4 trillion operations per second (TOPS) for high-speed image and video data processing. The Google Coral Edge TPU is for artificial intelligence (AI), machine learning and deep learning. Compared to an application with simple USB-cameras without TPU at approx. 6 frames per second, the embedded computing unit accelerates to a speed of 30 frames per second, so five times faster. For more information contact Kontron online at <https://www.kontron.com>.

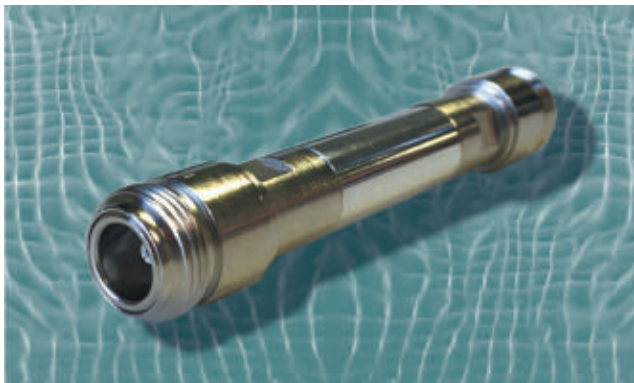
#### INTERCONNECT PRODUCTS

##### ► **Rugged board connectors for extreme conditions introduced by Nicomatic**

Nicomatic in Bons-En-Chablais, France, is introducing the EMM series board connectors that meet the performance requirements of MIL 83513-G and MIL-DTL 55302G to reduce space and weight in extreme environments military and space applications. The 1.27-millimeter pitch EMM interconnects effect a 40 percent space reduction over their parent CMM series and a 20 percent space saving when compared to standard Micro D connectors. The connectors come







### ATTENUATORS

#### ▲ Fixed attenuators for radar, test, and measurement introduced by BroadWave

BroadWave Technologies Inc. in Greenwood, Ind., is introducing the model series 352-210-12X\* line of 50-Ohm 2-Watt fixed attenuators for analyzing harmonic signals or isolating a device under test. Applications include RF and microwave equipment, telecommunication systems, base stations, radar applications, high precision applications such as military and defense programs. These attenuators reduce the amount of power delivered in a transmission line without introducing much noise or distortion, and are rated at 2-Watts average power with 1.40:1 maximum voltage standing wave ratio (VSWR). The operating frequency range is DC to 2500 MHz, attenuation values are 1 to 40 decibels, the operating temperature range is -55 to 100 degrees Celsius and the RF connectors are N female / N female. For more information contact BroadWave Technologies online at [www.broadwavetechnologies.com](http://www.broadwavetechnologies.com).

### CHASSIS AND ENCLOSURES

#### ▼ Half-ATR SpaceVPX chassis for 6U VPX boards on spacecraft introduced by Pixus

Pixus Technologies in Waterloo, Ontario, is introducing VITA 78 SpaceVPX air transport rack (ATR) systems for spacecraft and other high-availability applications. These SpaceVPX ATR systems support 6U OpenVPX boards of 160- or 220-millimeter depths. The half-ATRs support as many as four slots at a 1.2-inch pitch for the wider-slot-spacing of SpaceVPX. The backplane and I/O front panel configurations are customizable to each application. The embedded computing chassis incorporates SpaceVPX elements such as power redundancy, outgassing options, and other features of



the VITA 78 standard. Pixus offers OpenVPX and SOSA-aligned backplane and chassis systems in commercial, development, MIL rugged, and space formats. For more information contact Pixus Technologies online at <https://pixustechnologies.com>.

### MOTION CONTROL

#### ▼ Metric-size motors for voice coil actuators introduced by Moticon

Moticon in Van Nuys, Calif., is introducing metric-dimensioned motors to the company's LVCM series of linear voice coil actuators for laser beam steering and filtering, vibration damping, wafer handling, laser machining and drilling, and sorting applications. An example is the miniature LVCM-022-013-01M linear voice coil actuator. At 22.2 millimeters in diameter and at mid-stroke 20.7 millimeters long, this new metric miniature voice coil actuator has a continuous force of 14.5 ounces and a peak force of 45.7 ounces, with a 6.4-millimeter stroke. A miniature brushless DC servo motor, the LVCM-022-013-01M



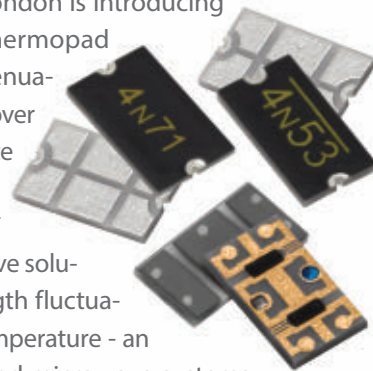
linear voice coil actuators have high acceleration and deceleration and low inertia. This miniature brushless servo motor is clean, has high speed, zero cogging, and is efficient. Additionally the metric LVCM-016-010-01 linear actuator features

high accuracy and repeatability when operated as a DC servo motor in a closed servo loop. Each end of this linear actuator has two M3X0.5 threaded mounting holes in the housing and two M3X0.5 threaded mounting holes in the coil end on 9.5-millimeter centers for integration into new and existing applications. For more information contact Moticon online at <http://moticon.com>.

### SPACE ELECTRONICS

#### ► High-reliability attenuator for space introduced by Smiths Interconnect

Smiths Interconnect in London is introducing the SpaceNXT K2TVA thermopad temperature variable attenuator for gain compensation over temperature in critical space flight applications. The high-reliability SpaceNXT K2TVA series offers a passive solution to offset signal strength fluctuation due to changes in temperature - an issue that affects all RF and microwave systems.



The attenuation shift over temperature comes from using thick-film thermistor inks that are screen printed onto a ceramic substrate of aluminum oxide. "The SpaceNXT K2TVA Thermopad series is Smiths Interconnect's response to the increasing demand for high-reliability connectivity in commercial space programs, particularly GEO, MEO, and LEO satellites," says Tullio Panarello, vice president and general manager fiber optics and components at Smiths Interconnect. Each product is engineered using 3D electromagnetic simulation software to provide TCA targeting, and to help obtain the best attenuation flatness and voltage standing-wave ratio (VSWR) within the specified frequency band. Designers can use the Thermopad in place of a standard chip attenuator to combine level setting or buffering and temperature compensation in a single chip design. This reduces the component count, whilst increasing reliability and lowering costs. For more information contact Smiths Interconnect online at [www.smithsinterconnect.com](http://www.smithsinterconnect.com).

#### RF AND MICROWAVE

##### ▼ Wideband amplifier family for radar and broadcast introduced by Ampleon



RF and microwave power specialist Ampleon in Nijmegen, The Netherlands, is introducing the 32-volt BLP15M9S12x and the 50-volt BLP15H9S12x wideband amplifier devices for radar, industrial heating systems, broadcast, particle accelerators, and plasma generators. The BLP15M9S12x and BLP15H9S12x families are based on the company's 9th generation LDMOS and high-voltage LDMOS technologies and support frequencies to 2 GHz. They are capable

of continuous wave (CW) and pulsed signal operation. The BLP15M9S12x wideband amplifier family comprises dedicated devices offering 100 Watts, 70 Watts, and 30 Watts. The BLP15H9S12x family supports devices delivering 100 Watts, 30 Watts, and 10 Watts. The BLP15M9S12x devices will deliver efficiencies of around 75 percent and with the BLP15H9S12x devices typically attaining 65 percent. Ampleon's BLP15M9S12x and BLP15H9S12x LDMOS amplifiers for RF and microwave applications come in compact SOT1482-1 (straight lead) and SOT1483-1 (gull wing) format packages. Their robust

construction ensures ongoing reliability. Use of plastic packaging helps maintain thermal performance, while also keeping unit costs down. Dual-side electro-static discharge (ESD) protection is incorporated into each device. For more information contact Ampleon online at [www.ampleon.com](http://www.ampleon.com).

#### ELECTRO-OPTICS

##### ▼ InGaAs quadrant pin receiver for optical communications offered by CMC Electronics

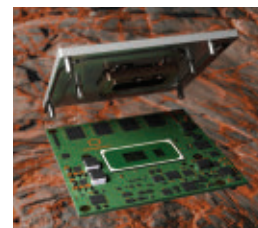


CMC Electronics Inc. in Saint-Laurent, Quebec, is introducing a 3-millimeter indium gallium arsenide (InGaAs) quadrant pin receiver for laser spot tracking, laser alignment, guidance, free space optical communications, position sensing, and laser range finding. This receiver detects wide optical signal levels and operates in harsh and varied environments. It also has a large active area with four transimpedance amplifiers (TIAs) in a compact hermetic package. The pin receiver module includes a standard ambient light rejection circuit, thus eliminating unwanted background light signals. It can detect optical signals at 1064 and 1570 nanometers to support eye-safe applications. Features such as single or multi-stage automatic gain control (AGC) provide high-dynamic range as well as elective input filtering for low cross-talk are available to enhance detection accuracy. Customization of this quadrant receiver is available. Different detector size, bandwidth, AGC levels, fast overload recovery, can be offered to fit customers' system design needs. Additional features can be incorporated without compromising the weight and size of the receiver. For more information contact CMC Electronics online at [www.cmcelectronics.ca](http://www.cmcelectronics.ca).

#### EMBEDDED COMPUTING

##### ▼ Rugged computer-on-module family for land vehicles introduced by Cognatec

Electronics manufacturer Cognatec Inc. in San Diego is introducing a rugged 11th-generation Intel Core processor-based computer-on-module family for challenging transportation and mobility applications. Target applications include self-driving robots, trains, land vehicles, construction machines, agricultural vehicles, and other mobile applications in challenging outdoor



## NEW PRODUCTS

and off-road environments. The COM Express Type 6 computer-on-module has soldered RAM for high shock and vibration resistance, and can withstand extreme temperature ranges of -40 to 85 degrees Celsius. Shock and vibration resistant stationary devices are another important embedded computing application area as digitization requires critical infrastructure protection against earthquakes and other mission-critical events. For price-sensitive applications, Cognatec also offers an Intel Celeron processor based variant that operates in temperatures from zero to 60 C. The computer on module offers LPDDR4X RAM with throughput of 4266 megatransfers per second and in-band error-correcting code for single-failure tolerance and high data transmission quality in environments with electromagnetic interference. For more information contact Cognatec online at [www.congatec.com](http://www.congatec.com).

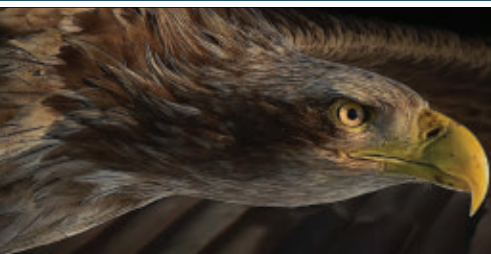


### TABLET COMPUTERS

#### ▼ Rugged detachable tablet computer for harsh-environments introduced by Panasonic

Panasonic System Solutions Company of North America in Newark, N.J., is introducing the Toughbook G2 rugged detachable tablet with optional keyboard for military, aerospace, and industrial applications that must operate in harsh environments. The Toughbook G2 has a modular design and user-removable expansion packs (xPAK's) to address the evolving needs of today's mobile workforce and help users tackle tough mission-critical jobs and assignments. The Toughbook G2 offers three modular expansion areas and as many as 36 different xPAK combinations to enable users to customize the rugged computer to suit their own needs, with features like a serial port, thermal camera, barcode reader, and quick-release solid-state drive. Despite its modular

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design, the device is backward-compatible with most Toughbook 20 and G1 docks. The computer has a 10.1-inch display, is powered by Intel Core i5 and i7 vPro processor (with Intel vPro technology), and is available with the Windows 10 Pro software operating system. An evolution of the Toughbook G1 tablet and Toughbook 20 laptop, the Toughbook G2 offers 18.5-hour battery life as standard, and has three programmable buttons to commonly used applications and shortcuts. The 2-in-1 detachable design enables users to operate the device in laptop and tablet modes, with the ability to dock or mount the device on forklifts, emergency vehicles, and desktops. The computer offers a 1,000 nit display; 3 modular expansion areas; Wi-Fi 6 and Bluetooth 5.1; 16-to-32 gigabytes of memory; 512-megabyte to 1 terabyte of OPAL quick-release NVMe solid-state memory; dDual SIM (physical and eSIM); and 88 dB loudspeakers. For more information contact Panasonic online at <https://na.panasonic.com/us/computers-tablets-handhelds/tablets/tablets/toughbook-g2>. ←

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# Programmable Linear InGaAs Balanced Optical Receiver Lab Buddy with Automatic Gain Control up to 56 Gbaud

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The DSC-R422 is a Linear AGC Balanced Photo-receiver suited for a variety of analog and digital applications, including coherent and direct detection systems. The R422 offers a variety of characteristics such as RF gain, output amplitude, and mode of operation (AGC or manual gain control). The R422 offers up to 33 GHz bandwidth, gain up to 2800 V/W, low power dissipation and a peak detect function.

The DSC-R422 is available in Discovery's computer-controlled Lab Buddy instrument, where several critical parameters can be controlled and monitored locally or remotely using Standard Commands for Programmable Instruments (SCPI) compatible commands via standard RS232C-over-USB interface. The DC photocurrents of both photodiodes can be monitored simultaneously over a nano-ampere (nA) to milli-ampere (mA) range on the Lab Buddy's digital display or via a custom GUI provided by Discovery. Additionally, the GUI can be used to control different functions of the DSC-R422 Lab Buddy.

DSC-R422 is available in a standalone Lab Buddy, or as a line card in our Configurable Lab Buddy platform.

## OPERATING FEATURES

- Two modes of operation: AGC or manual gain control
- Differential conversion gain up to 2800 V/W
- Operating wavelength from 1000 nm to 1650 nm
- Maximum differential RF output >500 mVpp
- Continuous DC photocurrent readout from nA to mA range
- Low optical PDL (0.05 dB typical)

## APPLICATIONS

- Ideal for Engineering design verification and production testing
- Digital coherent systems, including DP-QPSK and 16QAM, up to 56 Gbaud
- Coherent PON
- Direct detection for DPSK and DQPSK
- Analog and RF photonics applications to 33GHz
- Free space communications links

